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EXPERIENCE WITH THE ELECTRIC LOCOMOTIVE IN BALTIMORE.

BY LEE H. PARKER.

After a short period of experimental work, electric locomotive No. 1 on August 4, 1895, took up the regular freight service through the Belt Line Tunnel of the Baltimore & Ohio Railroad in the city of Baltimore. A brief restatement of the reasons for adopting electricity in this tunnel will not be out of place.

The tunnel, which is the largest "soft dirt" tunnel ever built, extends from the present Camden passenger station of the Baltimore & Ohio Railroad a distance of 7,350 feet north under the heart of the city. Beyond the northern portal the Belt Line continues through a series of short tunnels and cuts for a distance of about five miles, where it joins the old main line. The main tunnel has an up grade of .8 per cent going north. The heavy work that would be required of steam locomotives hauling freight trains up this grade would occasion the filling of the tunnel with so much gas and smoke as to seriously interfere with the passenger service. To show how true this is, it may be said that before the electric locomotives were put into service a few freight trains were run through the tunnel, but the result was that several men were asphyxiated, and it was therefore determined not to commence even a part of the regular freight service until the completion of the electric equipment.

The illustration, Fig. 1, gives an idea of the location of the tunnel and of what its use accomplishes. By its means a reduction of 16 minutes in the running time of the "Blue Line" trains between New York and Washington is now made possible, and it is probable that this saving will be increased later on. Moreover, all delays in Winter, due to ice in the river, are done away with.

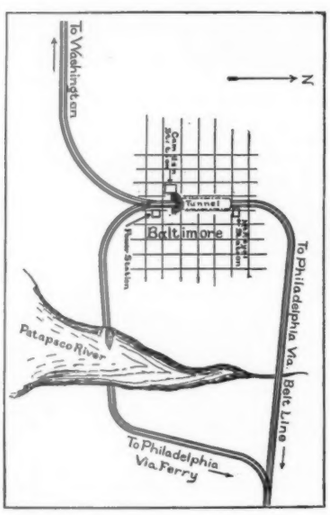

FIG. 1.—MAP SHOWING LOCATION OF THE BALTIMORE & OHIO TUNNEL IN BALTIMORE, MD.

Shortly after locomotive No. 1 had been put into service, and had given an exhibition of its ability to haul the heaviest freight trains, it became a matter of general interest as to how much it could pull and how fast it could go. The locomotive was, therefore, given a trial at hauling several of the passenger trains at high speeds, which it did satisfactorily to all concerned. As the conditions for operating the passenger trains entirely by the electric locomotive could not, on account of track facilities, be perfected until the new Mount Royal station, at the northern portal of the tunnel, was completed, it was decided to operate them in the meanwhile by coke-burning, steam locomotives. The new Mount Royal station will be ready in April or before, and preparations are now being made to then operate all trains, both freight and passenger, by the electric locomotives.

It was shown from the few trials made with passenger trains that not only could the guaranteed speed of 30 miles an hour be attained, but speeds of 35 and 40 miles with 500-ton trains were possible. An exhibition of high speed was made with the locomotive running light up the .8 per cent grade, and a speed of 61 miles per hour was attained for a short time without the slightest trouble from trolley or motors. Several of the many exhibitions made by the locomotives in pulling heavy loads have been described in the newspapers. Probably the most striking was when two trains were coupled together and hauled through the tunnel. For some reason the freight trains had become "bunched" on the Washington division, and when they did get through they came so fast that it was decided to have the electric locomotive haul them two at a time. The first composite train therefore consisted of 44 cars, loaded with coal and lumber, two regular steam freight engines and a steam "pusher" engine. The whole weight was approximately 1,900 tons, and was equivalent to about 52 loaded cars. The steam locomotives did no work to assist the electric locomotive. The start was made easily and gradually, but when the train was in the tunnel and entirely on the grade, the steady, heavy pull was too severe on a defective coupling near the head of the train, and it parted. After coupling together again the electric locomotive started the heavy train, with all drawbars stretched—no slack in the train—and accelerated it to a speed of 12 miles an hour without slipping a wheel and in every way with the greatest ease. It reminded one of the start of an ocean steamship, so noiseless was it and so free from any manifestations other than those of mighty power. The current recorded on the ammeter was about 2,200 amperes during the acceleration period, and, after the train was up to speed, it settled down to about 1,800 amperes. The voltage on the line was 625. By reading the amperes we were able to readily compute the drawbar pull, and found it to be about 63,000 pounds. All four motors were in series, and we were, therefore, getting the maximum pull for that current.

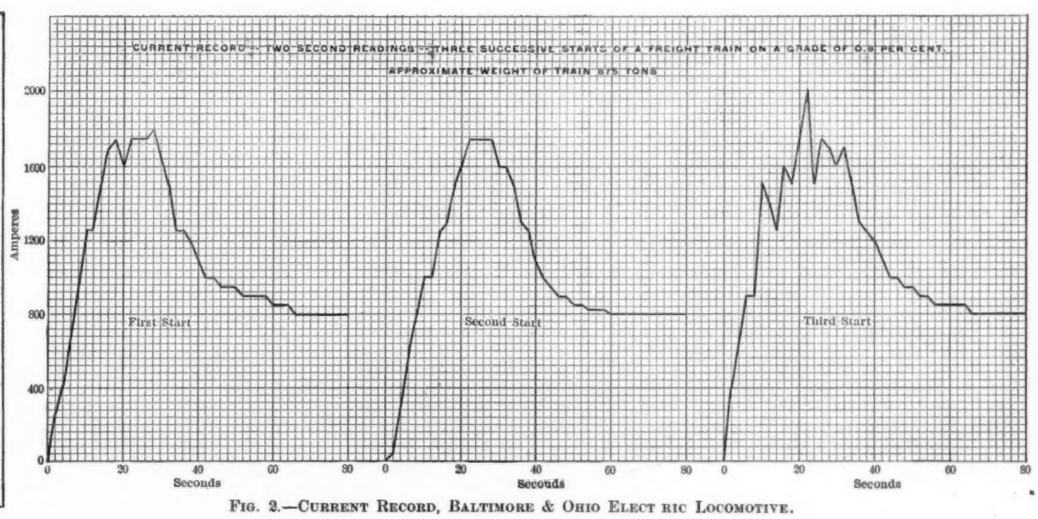

FIG. 2.—CURRENT RECORD, BALTIMORE & OHIO ELECTRIC LOCOMOTIVE.

It may be of interest to steam railway engineers to know how we determined the drawbar pull exerted for each ampere of current put into the locomotive. The Pennsylvania Railroad Company's dynamometer car was secured and coupled in between the electric locomotive and a train of known weight. The weight of each car in pounds had been accurately determined beforehand. The regular two-mile haul up grade was then made. When the train was in the tunnel on the grade the pull was uniform, as was shown in the diagrams taken on the dynamometer car.

When no drawbar pull was recorded, the pen rested on base line No. 1. The height or ordinate of the irregu-

lar curve at any point represented the drawbar pull at that instant. Measuring the same in inches and subtracting a constant and then multiplying by 4,000, gave the drawbar pull in pounds; *i. e.*, every inch in height represented 4,000 pounds. The paper traveled under the pen at a rate proportional to that of the train. An irregular line marked No. 2. Above the base line was the planimeter record, from which was determined the mean pull for any time. Having, then, the velocity or the feet per minute and the mean pounds pull exerted during any period, we readily obtained the horse-power developed.

Another line on the diagram showed the chronograph record, each of the small offsets in the line occurring every five seconds. For every 100 feet the train moved, the paper moved an inch. The distance in inches between any two of the offsets gave us readily the velocity of the train. Another line represented the time readings of current and voltage which were taken in the locomotive, a push-button in the locomotive being electrically connected with this recording apparatus. These readings were numbered, so it was easy to tell the current at any time and location. Still another line showed a record of the different stations in the tunnel. From this we determined the location of the train at any time.

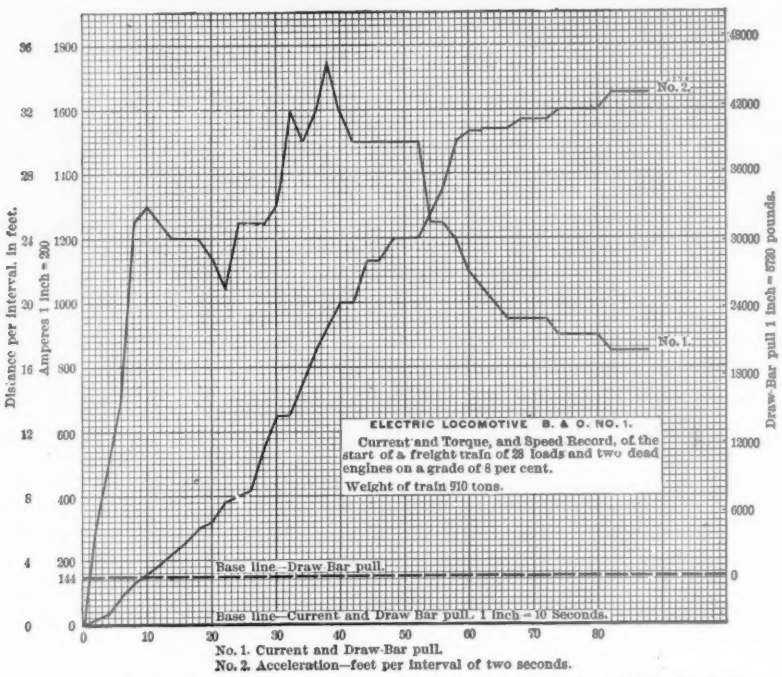
Distance per interval, in feet.
Amperes 1 inch = 200
Draw-Bar pull 1 inch = 6720 pounds.
No. 2.
No. 1.
ELECTRIC LOCOMOTIVE B. & O. NO. 1.
Current and Torque, and Speed Record, of the start of a freight train of 28 loads and two dead engines on a grade of 8 per cent.
Weight of train 910 tons.
Base line—Draw Bar pull.
Base line—Current and Draw Bar pull. 1 inch = 10 Seconds.
No. 1. Current and Draw-Bar pull.
No. 2. Acceleration—feet per interval of two seconds.

FIG. 3.—ACCELERATION AND CURRENT CURVES, BALTIMORE & OHIO ELECTRIC LOCOMOTIVE.

The first test showed (a) how the start was made on the down grade leading to the tunnel; (b) how, after the train was fully started, the drawbar pull dropped off; then (c) how it gradually increased as the train came on to the .8 per cent grade in the tunnel; and (d) after the train was wholly on the grade, how even the pull was, until near the stop, when the grade increases to 1.2 per cent. Mr. Dunbar, the official of the Pennsylvania Railroad Company in charge of the car, showed some diagrams of steam locomotive work under similar conditions, and it was seen that their amplitude of vibrations was considerably greater than those of the electric locomotive. This was undoubtedly due to the absence of the angle crank on the electric locomotive, and because its pull is uniform throughout the entire revolution of the armature. Most of the vibrations of the pen shown on these curves were due to vibrations of the dynamometer car, which was mounted on a single truck.

From test No. 1 we obtained the total drawbar pull in pounds, and, knowing the weight of the train, we found the drawbar pull to be 22+ pounds per ton of weight. Subtracting the grade pull, which, in the case of an .8 per cent grade, is 16 pounds, we obtained 6+ pounds per ton as the train resistance. This confirms the usual allowances made for freight train resistance. These observations were taken in September, 1895, on a very hot day. During the past Winter months the train resistance has increased, due, no doubt, to greater journal friction, caused by thickened lubricants, and we find it to be from our records about 20 per cent to 30 per cent greater than in September.

Test No. 2 was made after we had switched off six cars. The run was made under similar conditions and the same character of observations were made. The difference in drawbar pull of the two trains would naturally be the drawbar pull necessary for the six cars switched off. We had their exact weight and were thus again able to find what the drawbar pull per ton was. It was a check on our first figure and was very close to it, the slight difference we found being due to one brake on the six cars being partially set during the first run and unknown to any one.

We had the readings of current during the first run, also during the second. The difference of these should show the current required to haul the six cars switched off. Dividing the difference in the drawbar pulls recorded in the two tests by the difference in current recorded, gives us directly the net drawbar pull in pounds per ampere of current. This was 28.6 pounds.

It will, of course, be noted that by this method we eliminated the current required to drive the locomotive. To determine how much this was, and to check our conclusions, we divided the drawbar pull in pounds recorded in the first test by 28.6 and thus obtained the current that should exert that net drawbar pull. Subtracting this current from the current actually recorded on the locomotive would give the current required to drive the locomotive. We found it took 144 amperes. As a further check we figured similarly for the second test and obtained precisely the same; *i. e.*, 144 amperes. So at any time now when hauling a train with the four motors in series, if we take the current indicated on the amperemeter and subtract the 144 amperes needed for the locomotive, and multiply the remainder by 28.6, we have the total net drawbar pull in pounds; and if we divide this by the drawbar pull per ton, we get the tons of load we are pulling.

From the results obtained above we are able to show the current and drawbar pull at any moment while accelerating a train. The curves, Figs. 2 and 3, explain themselves very fully.

The acceleration curve, Fig. 3, was obtained in a rather humorous manner. It was necessary to have a means of marking the location of the locomotive at the end of every interval of two seconds. It was first attempted to count the number of incandescent lamps passed in each interval, as they are 15 feet apart, but it would often occur that the interval would end when the pointer was at some position between two lamps, and, therefore, it was impossible to estimate accurately how far we were from the next lamp. Some one suggested dropping something as a marker on the track at the expiration of each interval. That suggestion was followed by a large number of others as to the nature of that "something." The roadbed in the tunnel is very dark colored in the dim light and is rock ballasted, consequently the "something" should be light colored, non-breakable, and what would not bound out of place when dropped. Some one then suggested a handful of flour. This was adopted and it was soon tried. It was all right for slow speeds, but at 16 feet a second it was impossible to prevent it from blowing away. Having procured a large supply of flour, perhaps 20 pounds, and wishing to make use of it somehow, some one volunteered the suggestion that flour and water made dough, and that a doughball was light colored and that it would not bound, etc. It was decided at once to use doughballs, and they were the markers used in determining the distances traveled in each interval, as shown on the curves in Fig. 3.

When it comes to a comparison of the economy of electric and steam locomotives it is readily seen that it is a difficult undertaking, knowing, as we do, the figures of only a single isolated electric plant operating under special conditions and for a comparatively short time. One great incidental advantage of electric locomotives in tunnel service is that they are smokeless. This is an important moral consideration, but one which can hardly be computed in dollars and cents. But it may be of general interest to know how the actual operating expenses per engine mile of the electric locomotives during October, 1895, compare with those of a prominent and large eastern railway for the same month.

For the operation of the Baltimore & Ohio tunnel power house for the month of October, 1895, the itemized expenses were as follows:

Labor	$1,345 70
Coal ($1.35 per ton)	400 96
Oil and waste	151 26
Water	50 66
Maintenance	25 42
Total	$1,974 00

The expense on electrical locomotives was:

Motor engineers	$200 00
Oil and waste	12 16
Total	$212 16
Total expense	$2,186 16

There were hauled through the tunnel 353 trains.

Average weight of train	1,095 tons.
" time of trip	20 minutes.
" current	986 amperes.
Distance of trip	4 miles.
Total engine travel	1,412 "
" " " "idle"	3,756 "
Actual time consumed for above service	118 hours.
Idle time for month	626 "

It is customary to consider an engine with steam up as equivalent to six engine miles for each hour it is idle, so that, for comparison, the actual mileage made by the engines must be increased $6 \times 626 = 3,756$ miles.

The large charge of labor at power house will be the same for one, two or three locomotives in service. The items—coal, water and maintenance—and the expense on locomotives increase with the number of locomotives in service. If we assume this increase to be proportional, the total expense and cost per engine mile are as follows:

	Total cost.	Engine miles.	Cost per engine mile.
For one locomotive	$2,186 16	5,168	$0.423
" two locomotives	2,875 36	10,336	.278
" three "	3,564 56	15,504	.23

The steam railway records referred to above are for October, 1895, and may be briefly abstracted as follows:

STEAM LOCOMOTIVE PERFORMANCE.

	Eastern division.	Western division.	Central division.	N. & W. division.	Entire line.
Locomotives in service	74	57	33	28	19
Average engine mileage in service	2,834	2,966	2,293	2,305	2,70
Average cost per engine mile:					
Passenger engines	.1926	.1666	.1629	.1552	.1765
Freight "	.2472	.2656	.3428	.2303	.2615
Switching "	.1489	.1659	.1828	.1425	.1577
Work "	.2391	.2258	.2617	.2169	.2354
Total "	.2084	.2193	.2121	.1797	.2095

From the figures given above it is seen that the actual operating expenses of the electric locomotives for that particular month are about the same as for the freight locomotives on the steam railroad; *i. e.*, 23 cents per engine mile. The service of the electric locomotives at that time was only about one-third that which it is expected they will have to do when the passenger service is taken up and the line extended the full distance.

As originally intended, a method of using to advantage the power of the station while the electric locomotives are idle is soon to be incorporated in the plant. Under the new conditions the cost per engine mile for the electric locomotives will be far under that of steam.

A comparison of the efficiencies of steam and electric locomotives shows slightly in favor of the electric. Observations made on French railways and on the Pennsylvania railroad show that about 45 per cent to 55 per cent only of the indicated horse-power of steam locomotives is applied to hauling trains. The efficiency of the Baltimore & Ohio plant is in the vicinity of 60 per cent to 65 per cent under normal conditions.

A word may be added as to our experience with the overhead conductor system. The conductor in the tunnel has now been in position for nine months. During all of this time coke-burning locomotives have been used for passenger service, with the consequent presence of a good deal of gas and vapor. For the first six months about half of the conductor was constantly wet from the drip due to leaks in the masonry. This occasioned a muddy, slimy deposit over the insulators and a con-

(Concluded on page 132.)

TESLA'S STARTLING RESULTS IN RADIOGRAPHY AT GREAT DISTANCES THROUGH CONSIDERABLE THICKNESSES OF SUBSTANCE.

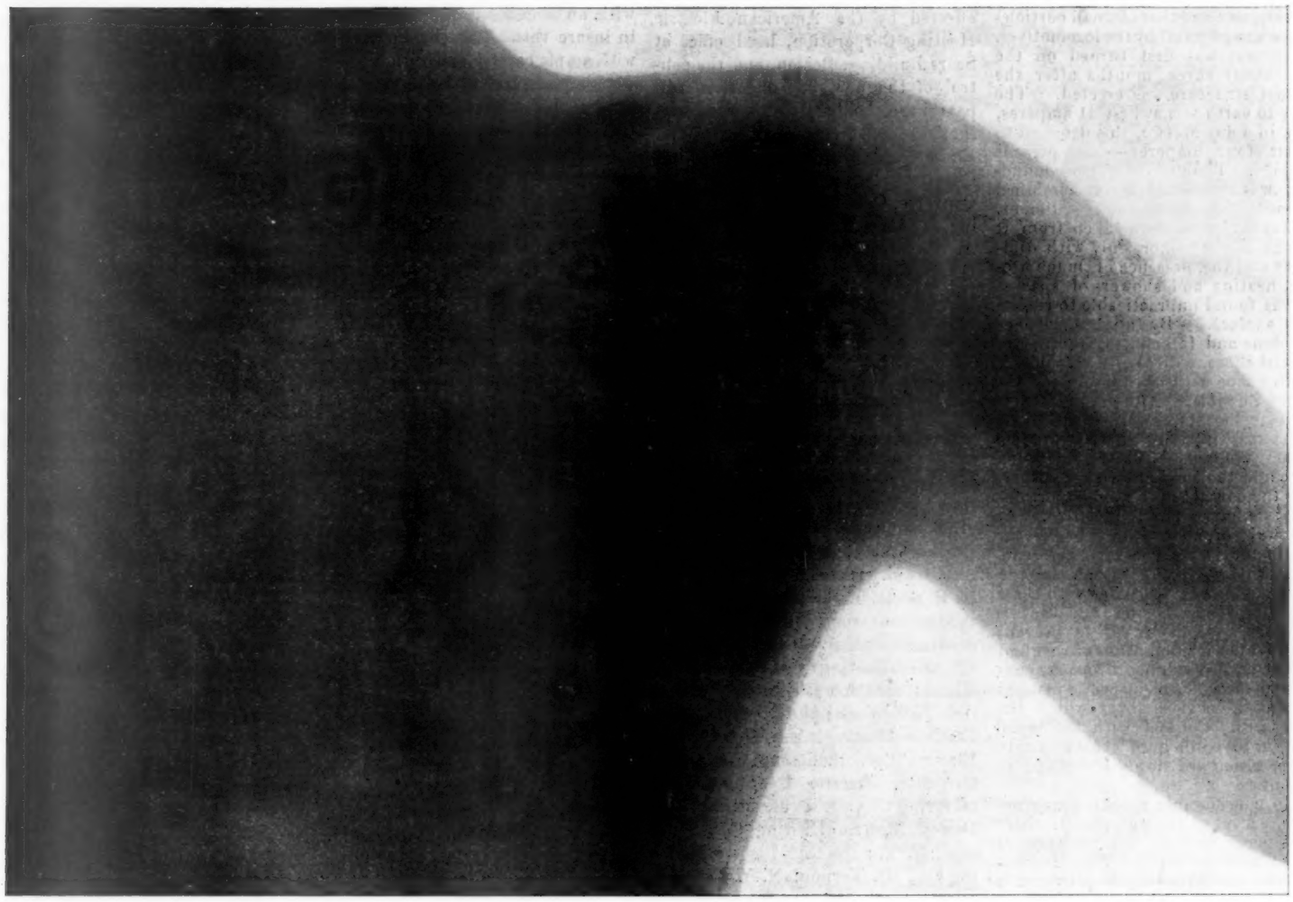

FIG. 1.—PHOTO-ENGRAVING OF TESLA RADIOGRAPH OF RIGHT SHOULDER OF A MAN, SHOWING RIBS AND SHOULDER AND UPPER ARM BONES—TAKEN THROUGH CLOTHING, BOARD, ETC., AT A DISTANCE OF FOUR FEET.

TESLA ON ROENTGEN RAYS.

A HIGHLY INTERESTING AND VALUABLE COMMUNICATION FROM THE TALENTED YOUNG INVENTOR.

TO THE EDITOR OF ELECTRICAL REVIEW:

One can not help looking at that little bulb of Crookes' with a feeling akin to awe, when he considers all that it has done for scientific progress—first, the magnificent results obtained by its originator; next, the brilliant work of Lenard, and finally the wonderful achievements of Roentgen. Possibly it may still contain a grateful Asmodeus, who will be let out of his narrow prison cell by a lucky student. At times it has seemed to me as though I myself heard a whispering voice, and I have searched eagerly among my dusty bulbs and bottles. I fear my imagination has deceived me, but there they are still, my dusty bulbs, and I am still listening hopefully.

After repeating Professor Roentgen's beautiful experiments, I have devoted my energies to the investigation of the nature of the radiations and to the perfecting of the means for their production. The following is a brief statement which, I hope, will be useful, of the methods employed and of the most notable results arrived at in these two directions.

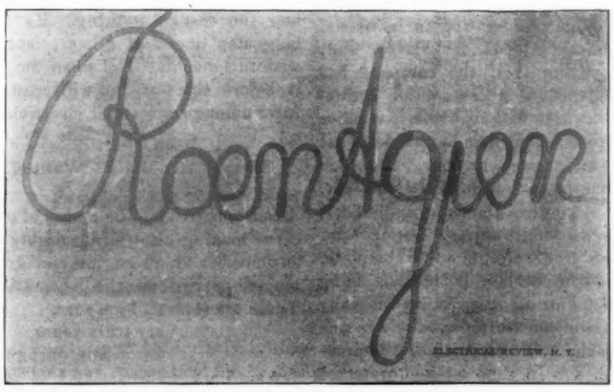

FIG. 2.—TESLA'S RESPECTS TO PROF. ROENTGEN—A RADIOGRAPH OF A WIRE SIGN TAKEN THROUGH A WOODEN COVER AT THE REMARKABLE DISTANCE OF ELEVEN FEET, WITH ONE-HALF HOUR'S EXPOSURE.

In order to produce the most intense effects we have first to consider that, whatever their nature, they depend necessarily on the intensity of the cathode streams. These again being dependent on the magnitude of the potential, it follows that the highest attainable electrical pressure is desirable.

To obtain high potentials we may avail ourselves of an ordinary induction coil, or of a static machine, or of a disruptive discharge coil. I have the impression that most of the results in Europe have been arrived at through the employment of a static machine or Ruhmkorff coil. But since these appliances can produce only a comparatively small potential, we are naturally thrown on the use of the disruptive discharge coil as the most effective apparatus. With this there is practically no limit to the spark length, and the only requirement is that the experimenter should possess a certain knowledge and skill in the adjustments of the circuits, particularly as to resonance, as I have pointed out in my earlier writings on this subject.

After constructing a disruptive coil suitable for any kind of current supply, direct or alternating, the experimenter comes to the consideration as to what kind of bulb to employ. Clearly, if we put two electrodes in a bulb, or use one inside and another outside electrode, we limit the potential, for the presence not only of the anode but of any conducting object has the effect of reducing the practicable potential on the cathode. Thus, to secure the result aimed at, one is driven to the acceptance of a single electrode bulb, the other terminal being as far remote as possible.

Obviously, an inside electrode should be employed to get the highest velocity of the cathode streams, for the bulbs without inside terminals

(Continued on page 134.)

EXPERIENCE WITH THE ELECTRIC LOCOMOTIVE IN BALTIMORE.

(Concluded from page 130.)

siderable portion of the conductor. The porcelain insulators are almost entirely obscured in some places by this deposit and that of small particles of carbon given off by the locomotives.

Current was first turned on the line about three months after the tunnel structure was erected. The leak to earth was at first 21 amperes, but, in a day or two, this dropped to about four amperes — the present leakage. The inside of the conductor was coated with a combined deposit of rust and muddy sediment. Heavy currents were taken from it by the contact shoe only with difficulty and the presence of much arcing, heating and showers of sparks. It was found impracticable to run on this surface. By applications of kerosene and frequent scraping with special shoes, a direct contact of the trolley shoe with the conductor was made possible. Although a single contact shoe then worked with little or no sparking, two shoes in tandem were adopted. Their operation through the conductor is smoother, and the contact over muddy portions of it is more nearly positive. At intervals of about three weeks the conductor is treated with kerosene, and brushing shoes are run through it, about one or two trips with these brushing shoes being all that is necessary. This serves to prevent the further accumulation of rust and to remove the sediment from the contact surfaces. An inspection shows a smooth surface over which the shoes run. Contact with the metal is seen to be in high spots and thin lines, which are slowly increasing in extent.

No considerable sparking now occurs, except at the wet places, where it is occasioned by the presence of water and sediment. With the exception of three places, about 200 feet long each, the conductor is at present dry.

The bolts to the arch of the tunnel are both galvanized and painted. They show no signs of rusting. The painting has, in general, protected the surfaces of the conductor and channels. The sides and top of the inside of the conductor are coated with rust. Most of this is hard and close grained; some of it, however, is flaky. In no case is there apparent a reduction of thickness of any of the ironwork, due to rusting. Outside the tunnels the conductor is in uniformly good condition. It adapts itself to changes of temperature without trouble. The inside of the conductor is coated with rust, but in no case has there been any trouble from it. The deposit appears to be very light. There was at no time any sparking between contact shoes and conductor outside of the tunnel.

The Electrical Exposition.

Mr. C. E. Stump, general manager of the Electrical Exposition which is to be held in the New York Industrial Building in May, informs the ELECTRICAL REVIEW that applications for space are coming in now more rapidly than ever. The display in the steam department will be especially handsome and interesting. At the present time 10 steam engines have been entered, all of which will operate various kinds of machinery. The National Electrical Exposition Company has also contracted with the Abendroth & Root Manufacturing Company, of New York city, for a battery of boilers of 500 horsepower to furnish steam for the engine exhibits.

Combination of Electric Heating Companies.

After six months of negotiation, the absorption of all the important electric heating companies has been effected by the American Electric Heating Corporation, head office at Sears Building, Boston, and the control of the new consolidation will pass into the hands of a syndicate including Charles A. Morss, Wm. Endicott, Jr., Charles E. Perkins, Charles J. Paine, Oliver Ames, E. S. Converse, C. C. Converse, E. L. Corning, Thomas Nelson, E. N. Fenno, A. R. Whittier, Jackson & Curtis, E. D. Barbour, Robert Bradley, Peter Bradley, Robert Treat Paine, Jr., and others.

The new board of directors will consist of J. Murray Forbes, president; Charles A. Morss, Jr.; Edward C. Perkins; Charles L. Edgar, of the Edison Electric Light Co.; Charles Francis Adams, 2d; Everett Morss; Arthur B. Smith; Geo. U. Crocker; Ambrose Eastman, of Boston; S. S. Wheeler, of the Crocker-Wheeler Electric Co., and Arthur M. Dodge, of New York; H. B. Scott, of Burlington, Iowa.

The concerns absorbed by the American company are: the Western Electric Heating Co., St. Paul, Minn.; the Central Electric Heating Co., New York; the New England Electric Heating Co.; the Burton Electric Co., Richmond, Va.; the Carpenter Electric Heating Manufacturing Co., St. Paul, Minn.; the Dewey Electric Heating Co., Syracuse, N. Y.; the Rich Electric Heating Co., Mt. Vernon, N. Y.; as well as several others which have not been active in the business for some time, but which owned valuable patents.

Heating by electricity is now a commercial success, and, in addition to the large number of patents now owned by the American Corporation, it also owns the patents covering the enamel process, which has already proved of great value in rheostats, and it is believed will be of equal importance in many other devices.

The opportunity for the application of electric heating in industrial establishments is very large, and, recognizing this, the company has established a laboratory for special work, which will enable it to care for this class of business in an intelligent and satisfactory manner. The line of cooking devices now on the market, as well as other domestic appliances, such as small stoves, laundry and tailors' irons, etc., is quite complete, and a comsiderable business is being done. During the past season many thousand car heaters were sold by the company. While much of the product has been very satisfactory, that which is not so will receive immediate attention, and several improvements are in hand which will prove to be desirable additions. This especially applies to cooking apparatus, car heaters and special industrial devices.

The slow progress heretofore made in electric heating has not been owing so much to difficulty in perfecting devices as to want of concentration of patent rights and management and to insufficient capital.

The policy of this company is to furnish the best that the state of the art will permit, and they are provided with an able corps of practical men to insure this. They begin business with ample capital and with a list of stockholders and a board of directors composed of substantial and conservative business men.

The manufacturing will be concentrated at Cambridgeport, and the head office is at 611 Sears Building, with agencies in New York and Chicago. Mr. James I. Ayer, ex-president of the National Electric Light Association, is the general manager.

Submarine Electric Search-Lights.

Two little boys were recently drowned in the Lehigh Canal at Catasauqua, Pa. Great difficulty was experienced in searching for the bodies. The local electric light company put up arc lights along the tow-path to assist the searchers in their work.

Finally, Mr. Wm. M. Morrison, electrician of the electric light company, made several submarine electric search-lights for men in boats to use. These consisted of incandescent lamps surrounded by water-tight globes attached to the ends of long iron pipes, through which waterproof wires were carried. The operator sat in the stern of a boat and the waters and bottom of the canal were thoroughly searched. The hastily improvised apparatus worked splendidly and one of the bodies was found by means of it.

Nathan's Machine Will Run Forever.

[*From the Murray, Ky., Ledger.*]

Mr. Nathan Stubblefield is exhibiting his new and wonderful machine, which he has spent several years in perfecting. It is an electrical apparatus that will run forever, and, what is better, can be practically applied to the running of machinery and the cost is nothing. He is a long step ahead of other scientists with this machine, and when he gets it before the world it will create a furor among the learned electricians.

Electric Headlights Wanted.

TO THE EDITOR OF ELECTRICAL REVIEW:

Can you give me the names of concerns making electric headlights for locomotives where engine and dynamo are carried on the locomotive? There are several, I am sure.

Very truly yours,
SUBSCRIBER.

New York, February 29.

Electric Light in the West Indies.

At Bridgetown, Barbadoes, British West Indies, Mr. G. Wilberforce Grant has installed an electric light plant consisting of an Edison bipolar 120-light dynamo driven by a Harrisburg Ideal engine made by the Harrisburg Foundry and Machine Works, of Harrisburg, Pa.

Historical Exhibit at the Electrical Exposition.

In connection with the Electrical Exposition to be held in New York next May, arrangements have been made for a very interesting historical and loan exhibit, to which it is intended to devote considerable space on the main floor. A committee, composed of T. Commerford Martin, Dr. Park Benjamin and E. L. Morse, has been asked to take the superintendence of this exhibit, and, having consented to do so, is already at work. Dr. Benjamin has one of the finest libraries in the world of early books on electricity, and these will be shown in cases, arranged chronologically, with explanatory notes, portraits, autographs, etc. Mr. Morse, as the son of Prof. S. F. B. Morse, is the possessor of an invaluable collection of telegraphic relics, curios, documents, etc., including his father's note books and sketches, all of which will be shown. Mr. Martin, besides possessing many objects of interest connected with the early days of electricity, has secured from Mr. Tesla, Prof. Elihu Thomson, Mr. Edison, Mr. Edward Weston, Mr. Stieringer and others no less well known, the loan of early and interesting apparatus, constituting a personal exhibit from each inventor of the most instructive nature. It is believed that, judging even from present indications, the historical and loan collection will far surpass anything of the kind ever attempted in this country.

American Institute of Electrical Engineers.

At the meeting of the Institute on February 26 the report of the Committee on Incorporation was read, and a resolution empowering the Council to proceed with the work of incorporation was unanimously adopted.

The discussion of Mr. Sprague's paper on electric elevators was then taken up, in accordance with a vote of the meeting held on January 22, when lack of time prevented some members from participating. The discussion was reopened by Dr. Hutchinson, who presented the results of actual tests made. He was followed by Messrs. Geo. Hill, R. P. Bolton, H. Ward Leonard and others.

At the meeting of Council in the afternoon, ten associate members were elected and six associate members were transferred to full membership upon recommendation of the Board of Examiners.

KIND WORDS.

WANTS BACK NUMBERS, TOO.

TO THE EDITOR OF ELECTRICAL REVIEW:

We like your publication and would be pleased to receive it regularly. We would also like back numbers of 1896. Will forward draft for same as soon as they arrive. We are,

Yours respectfully,
A. B. & Co.

Racine, Wis., February 29.

TELEPHONE NEWS AND COMMENT.

The New York & Pennsylvania Telephone and Telegraph Company has just given a mortgage for $300,-

FIG. 1.—DEVEAU & COMPANY'S IMPROVED INTERCOMMUNICATING SYSTEM FOR FACTORIES AND OFFICE BUILDINGS.

000 to cover expenses of new improvements.

It is rumored that a new telephone company will be formed to operate in Jersey City, N. J.

The New York & New Jersey Telephone Company is introducing auxil-

FIG. 2.—DEVEAU & COMPANY'S NEW CARBON BALL TRANSMITTER CUP AND MOUTH-PIECE.

iary telephone sets in Paterson, N. J. The rental to regular subscribers is $30 a year for each set.

Pat. (at the telephone): Hilloo! Is this the feed shtore? Will, sind up at once a bale of hay, two quarts of

FIG. 3.—LONG-DISTANCE TRANSMITTER.

bran and a bushel of oats. Who is it fhore? Ah, don't git gay. It's fhore the horse.—*Life.*

Mr. Augustus Calder, metropolitan manager of the National Telephone Company, of London, died on February 3 of pneumonia. He was in his forty-third year and entered the telephone business in 1880.

It is reported that a Bell representative was in Iron Mountain, Mich., last week offering business telephones at $1 per month and residence telephones at 90 cents per month. These rates are about half those of the local Home company.

The Washtenow County Telephone Company, recently formed at Ann

FIG. 4.—OFFICE AND FACTORY TELEPHONE.

Arbor, Mich., has been granted a franchise. It offers the city free telephones. Rate for residences is $15 and for business houses it is $24. These are half the local Bell company's rates.

It is said that in its efforts to check the competition of the Home Telephone Company, the local Bell company at Marinette, Wis., and Menominee, Mich., has cut rates 75 per cent,

FIG. 5.—DEVEAU & COMPANY'S IMPROVED DESK TELEPHONE.

issuing scrip to subscribers, which is accepted as cash when accompanied by 25 per cent of the contract price.

The instrument statement of the American Bell Telephone Company for the month ended February 20 is as follows: Net output, 10,857, against 3,664 in 1895. Since December 20, net output, 20,909, against 5,350 in 1895. Total telephones outstanding, 697,445, against 587,856 last year.

Governor Frederick T. Greenhalge, of Massachusetts, died at Lowell on March 5 after a brief illness. He was in his fifty-fourth year. He had held many important political positions. In 1894 he vetoed the original bill authorizing the American Bell Tele-

FIGS. 6 AND 7.—TELEPHONE COMPLETE WITH INDEPENDENT SWITCH—DEVEAU & COMPANY'S FACTORY SYSTEM.

phone Company to increase its capital stock.

The stockholders of the Bell Telephone Company of Canada have authorized the board of directors to issue $600,000 additional 30-year five per cent debentures, making in all $1,200,000, to erect new buildings and lay underground wires in Montreal. The company reports gross earnings for the year ending December 31, $1,087,124; expenses, $787,249; net earnings, $299,874. A dividend of eight per cent was ordered paid. The paid-up capital of the company is $3,168,000.

Judge Shumway, on February 21, issued an injunction restraining the People's Telephone Company, of

FIG. 8.—BLAKE TRANSMITTER AND MAGNETO IN ONE BOX.

New Haven, Ct., from using the franchise under which it was recently established. The plaintiffs are J. C. Beekman and Martin Garrison, of New York, who claim prior rights to the franchise. The People's Telephone Company was organized in New Haven on February 20 with the following officers: President, ex-Judge Joseph Sheldon; vice-president and general manager, J. J. Hogan, and secretary and treasurer, James R. Bolton.

President Harvey M. Littell, of the American Street Railway Association, is an intensely practical man. He is on intimate terms with every minute piece of apparatus used on the great street railway systems of which he has had control. Mr. Littell himself admits that he can run a trolley car as well as any motorman in his employ.

Improvements in Telephone Manufacture.

The interest taken by the public in the work done by electrical manufacturers as it relates to the improvement of that now absolutely necessary instrument, the telephone, seems to constantly increase. Many manufacturing houses are developing this branch of their business and others are devoting their time and capacity to this interesting work exclusively. The ELECTRICAL REVIEW presents in this issue illustrations of the very complete and electrically excellent telephone system manufactured by DeVeau & Company, of New York city. This company was one of the first to enter the field of exclusive manufacture of modern telephones, and the thoroughness of their work is easily seen from the various uses of the instrument that they have provided for. The title beneath each illustration gives the information desired by every purchaser of telephones, and still further details will appear in a catalogue soon to be issued by this enterprising house.

The improved intercommunicating system, shown in Fig. 1, is a very compact and excellent arrangement. Each instrument carries its own switchboard, and communication is immediately secured with the instrument desired by turning the switch to the proper number. More than two persons can use the system at the same time. The long-distance transmitter, shown in Fig. 3, is one of the specialties of DeVeau & Company.

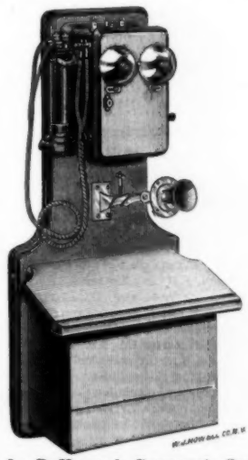

FIG. 9.—DEVEAU & COMPANY'S SPECIAL LONG-DISTANCE TELEPHONE SET.

It is ornamental as well as useful. The desk set, shown in Fig. 5, is also an ornamental as well as always-satisfying adjunct to a busy man's desk. These are handsomely made and have a uniform appearance.

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***CHANGES** for advertisements must be in this office by Friday noon for the following week's issue.*

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NEW YORK, MARCH 11, 1896.

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TESLA'S RADIOGRAPHS.

We publish a welcome addition to the Roentgen ray literature. It is from the always interesting pen of Nikola Tesla, and is the first authorized description of the experiments of this thorough and conscientious inventor. Mr. Tesla gives full credit to the discovery by Roentgen, and is personally much elated over discoveries of his own as his careful experiments are developed. The Tesla radiographs we present show wonderful results under severe conditions. While Tesla has heretofore been silent since the announcement by Roentgen, he has not been idle, but has evidently been striving for valuable and tangible results. Further information from his laboratory will be awaited with interest.

DECISION ON A VAN DEPOELE RAILWAY PATENT.

An interesting and important decision has just been rendered by Judge Townsend, of the United States Circuit Court for the district of Connecticut, upon the Van Depoele patent No. 495,443, for the underrunning electric railway trolley system. A few months ago Judge Townsend rendered a decision sustaining the validity of this patent upon final hearing in a suit against the Winchester Avenue Railroad Company. Shortly thereafter further infringement suits were brought in Connecticut against the Billings & Spencer company, of Hartford, and the Kelsey Electric Railway Specialty Company, of New Haven. Judge Townsend has just decided these suits in favor of the Van Depoele patent, and granted motions for preliminary injunctions after full argument on both sides. The decision is especially important because the court holds that the supply of essential or characteristic parts of the trolley system is a contributory infringement, and will be enjoined by the courts, even though the defendants may not supply or use the patented combination or system in its entirety. The court further held that an unlicensed maker of trolley bases could not be permitted to supply such bases even to railroads which had been originally fully equipped by the General Electric Company, the present owner of Van Depoele patent No. 495,443.

TESLA ON ROENTGEN RAYS.

(Concluded from page 131.)

are much less efficient for this special object in consequence of the loss through the glass. A popular error seems to exist in regard to the concentration of the rays by concave electrodes. This, if anything, is a disadvantage. There are certain specific arrangements of the disruptive coil and circuits, condensers and static screens for the bulb, on which I have given full particulars on previous occasions.

Having selected the induction apparatus and type of bulb, the next important consideration is the vacuum. On this subject I am able to make known a fact with which I have long been acquainted, and of which I have taken advantage in the production of vacuum jackets and all sorts of incandescent bulbs, and which I subsequently found to be of the utmost importance, not to say essential, for the production of intense Roentgen shadows. I refer to a method of rarefaction by electrical means to any degree desirable, far beyond that obtainable by mechanical appliances.

Though this result can be reached by the use of a static machine as well as of an ordinary induction coil giving a sufficiently high potential, I have found that by far the most suitable apparatus, and one which secures the quickest action, is a disruptive coil. It is best to proceed in this way: The bulb is first exhausted by means of an ordinary vacuum pump to a rather high degree, though my experiences have shown that this is not absolutely necessary, as I have also found it possible to rarefy, beginning from low pressure. After being taken down from the pump, the bulb is attached to the terminal of the disruptive coil, preferably of high frequency of vibration, and usually the following phenomena are noted. First, there is a milky light spreading through the bulb, or possibly for a moment the glass becomes phosphorescent, if the bulb has been exhausted to a high degree. At any rate, the phosphorescence generally subsides quickly and the white light settles around the electrode, whereupon a dark space forms at some distance from the latter. Shortly afterward the light assumes a reddish color and the terminal grows very hot. This heating, however, is observed only with powerful apparatus. It is well to watch the bulb carefully and regulate the potential at this stage, as the electrode might be quickly consumed.

After some time the reddish light subsides, the streams becoming again white, whereupon they get weaker and weaker, wavering around the electrode until they finally disappear. Meanwhile, the phosphorescence of the glass grows more and more intense, and the spot where the stream strikes the wall becomes very hot, while the phosphorescence around the electrode ceases and the latter cools down to such an extent that the glass near it may be actually ice-cold to the touch. The gas in the

bulb has then reached the required degree of rarefaction. The process may be hastened by repeated heating and cooling and by the employment of a small electrode. It should be added that bulbs with external electrodes may be treated in the same way. It may be also of interest to state that under certain conditions, which I am investigating more closely, the pressure of the gas in a vessel may be augmented by electrical means.

I believe that the disintegration of the electrode, which invariably takes place, is connected with a notable diminution of the temperature. From the point on, when the electrode gets cool, the bulb is in a very good condition for producing the Roentgen shadows. Whenever the electrode is equally, if not hotter than the glass, it is a sure indication that the vacuum is not high enough, or else that the electrode is too small. For very effective working, the inside surface of the wall, where the cathode stream strikes, should appear as if the glass were in a fluid state.

As a cooling medium I have found best to employ jets of cold air. By this means it is possible to operate successfully a bulb with a very thin wall, while the passage of the rays is not materially impeded.

I may state here that the experimenter need not be deterred from using a glass bulb, as I believe the opacity of glass as well as the transparency of aluminum are somewhat exaggerated, inasmuch as I have found that a very thin aluminum sheet throws a marked shadow, while, on the other hand, I have obtained impressions through a thick glass plate.

The above method is valuable not only as a means of obtaining the high vacua desired, but it is still more important, because the phenomena observed throw a light on the results obtained by Lenard and Roentgen.

Though the phenomenon of rarefaction under above conditions admits of different interpretations, the chief interest centers on one of them, to which I adhere—that is, on the actual expulsion of the particles through the walls of the bulb. I have lately observed that the latter commences to act properly upon the sensitive plate only from the point when the exhaustion begins to be noticeable, and the effects produced are the strongest when the process of exhaustion is most rapid, even though the phosphorescence might not appear particularly bright. Evidently, then, the two effects are closely connected, and I am getting more and more convinced that we have to deal with a stream of material particles, which strike the sensitive plate with great velocities. Taking as a basis the estimate of Lord Kelvin on the speed of projected particles in a Crookes' bulb, we arrive easily by the employment of very high potentials to speeds of as much as a hundred kilometres a second. Now, again, the old question arises: Are the particles from the electrode or from the charged surface generally, including the case of an external electrode, projected through the glass or aluminum walls, or do they merely hit the inner surface and cause particles from the outside of the wall to fly off, acting in a purely mechanical way, as when a row of ivory balls is struck? So far, most of the phenomena indicate that they are projected through the wall of the bulb, of whatever material it may be, and I am seeking for still more conclusive evidence in this direction.

It may not be known that even an ordinary streamer, breaking out suddenly and under great pressure from the terminal of a disruptive coil, passes through a thick glass plate as though the latter were not present. Unquestionably, with such coils pressures are practicable which will project the particles in straight lines even under atmospheric pressure. I have obtained distinct impressions in free air, not by streamers, as some experimenters have done, using static machines or induction coils, but by actual projection, the formation of streamers being absolutely prevented by careful static screening.

A peculiar thing about the Roentgen rays is that from low frequency to the highest obtainable there seems to be no difference in the quality of the effects produced, except that they are more intense when the frequency is higher, which is very likely due to the fact that in such case the maximum pressures on the cathode are likewise higher. This is only possible on the assumption that the effects on the sensitive plate are due to projected particles, or else to vibrations far beyond any frequency which we are able to obtain by means of condenser discharges. A powerfully excited bulb is enveloped in a cloud of violet light, extending for more than a foot around it, but outside of this visible phenomenon there is no positive evidence of the existence of waves similar to those of light. On the other hand, the fact that the opacity bears some proportion to the density of the substance speaks strongly for material streams, and the same may be said of the effect discovered by Prof. J. J. Thomson. It is to be hoped that all doubts will shortly be dispelled.

A valuable evidence of the nature of the radiations and progress in the direction of obtaining strong impressions on the plate might be arrived at by perfecting plates especially sensitive to mechanical shock or impact. There are chemicals suitable for this, and the development in this direction may lead to the abandonment of the present plate. Furthermore, if we have to deal with streams of material particles, it seems not impossible to project upon the plate a suitable substance to insure the best chemical action.

With apparatus as I have described, remarkable impressions on the plate are produced. An idea of the intensity of the effects may be gained when I mention that it is easy to obtain shadows with comparatively short exposures at distances of many feet, while at small distances and with thin objects, exposures of a few seconds are practicable. The annexed print is a shadow of a copper wire projected at a distance of 11 feet through a wooden cover over the sensitive plate. This was the first shadow taken with my improved apparatus in my laboratory. A similar impression was obtained through the body of the experimenter, a plate of glass, nearly three-sixteenths of an inch thick, a thickness of wood of fully two inches and through a distance of about four feet. I may remark, however, that when these impressions were taken, my apparatus was working under extremely unfavorable conditions, which admitted of so great improvements that I am hopeful to magnify the effects many times.

The bony structure of birds, rabbits and the like is shown within the least detail, and even the hollow of the bones is clearly visible. In a plate of a rabbit under exposure of an hour, not only every detail of the skeleton is visible, but likewise a clear outline of the abdominal cavity and the location of the lungs, the fur and many other features. Prints of even large birds show the feathers quite distinctly.

Clear shadows of the bones of human limbs are obtained by exposures ranging from a quarter of an hour to an hour, and some plates have shown such an amount of detail that it is almost impossible to believe that we have to deal with shadows only. For instance, a picture of a foot with a shoe on it was taken, and every fold of the leather, trousers, stocking, etc., is visible, while the flesh and bones stand out sharply. Through the body of the experimenter the shadows of small buttons and like objects are quickly obtained, while with an exposure of from one to one and a half hour the ribs, shoulder-bones and the bones of the upper arm appear clearly, as is shown in the annexed print. It is now demonstrated beyond any doubt that small metallic objects or bony or chalky deposits can be infallibly detected in any part of the body.

An outline of the skull is easily obtained with an exposure of 20 to 40 minutes. In one instance an exposure of 40 minutes gave clearly not only the outline, but the cavity of the eye, the chin and cheek and nasal bones, the lower jaw and connections to the upper one, the vertebral column and connections to the skull, the flesh and even the hair. By exposing the head to a powerful radiation strange effects have been noted. For instance, I find that there is a tendency to sleep and the time seems to pass away quickly. There is a general soothing effect, and I have felt a sensation of warmth in the upper part of the head. An assistant independently confirmed the tendency to sleep and a quick lapse of time. Should these remarkable effects be verified by men with keener sense of observation, I shall still more firmly believe in the existence of material streams penetrating the skull. Thus it may be possible by these strange appliances to project a suitable chemical into any part of the body.

Roentgen advanced modestly his results, warning against too much hope. Fortunately his apprehensions were groundless, for, although we have to all appearance to deal with mere shadow projections, the possibilities of the application of his discovery are vast. I am happy to have contributed to the development of the great art he has created.

NIKOLA TESLA.

New York, March 7, 1896.

Hudson River Telephone Company.

At the annual meeting of the stockholders of the Hudson River Telephone Company, which was held at the office of the company in Albany, N. Y., on Thursday, March 5, the old board of directors was re-elected, as follows: Joseph P. Davis, New York city; James Bigler, Newburgh, N. Y.; Selden E. Marvin, Albany, N. Y.; David B. Parker, Randolph, N. Y.; Henry L. Storke, Auburn, N. Y.; C. Jay French, Boston, Mass.; John E. Hudson, Boston, Mass.; James H. Manning, Albany, N. Y.; D. Cady Herrick, Albany, N. Y.

The report of the operations of the company for the year shows a gratifying increase in business and in net profits, although the average rate to subscribers has been considerably reduced. Several new exchanges have been added and there has been a net gain in subscribers' stations of 816 over the previous year. This is about 22 per cent, and the gain in metallic circuit subscribers has been 41 per cent. Nearly $80,000 has been expended from the earnings for the maintenance and betterment of the plant, and, notwithstanding this large investment, the net results for the year equal nearly five per cent on the outstanding capital of the company.

At a meeting of the directors, held immediately after the stockholders' meeting, the following officers were re-elected: President, Selden E. Marvin; vice-president, James H. Manning; secretary and auditor, Walter B. Butler; treasurer, James J. Fitzsimmons; general manager, Henry E. Hawley.

An Electric Light Company Loses Two Officers.

Stephen Powell, a leading and wealthy citizen of Hempstead, L. I., was murdered within 50 feet of his home last Saturday night. He was superintendent of the Hempstead Gas and Electric Light Company, besides having other important business interests. Mr. Powell always carried large sums of money in his pockets, and it is supposed that some one who knew this killed him, as most of the money he was known to have with him was taken. He was struck in the back of the head with an ax and was found lying in the street near his home. Two arc lights were burning within 400 feet of where he lay. Only a few days before this, Mayor Philip J. A. Harper, president of the Hempstead Gas and Electric Light Company, died.

A Parlor Car Trolley Ride.

President H. M. Littell, of the Atlantic avenue line, Brooklyn, took a party of Montauk club members on the beautiful parlor car "Montauk" to Coney Island on Saturday of last week. The trip began and ended at the Montauk Club. There were about 20 aboard. With music and refreshments the trip was hugely enjoyed. In the party were Messrs. Littell, Keating, Callahan, Candee, Snell, Berri, Price, Williams, Adams and Major Evans.

THE GENERATION AND DISTRIBUTION OF CURRENT BY AN EDISON STATION.

READ BEFORE THE NEW YORK ELECTRICAL SOCIETY, FEBRUARY 26, 1896, BY J. W. LIEB, JR.

On the afternoon of September 4, 1882, a small group was gathered in this city at 257 Pearl street, awaiting the approach of 3 o'clock. Orders had been given that a circuit breaker of one of the Edison "Jumbo" dynamos should be closed at that hour, establishing, for the first time, connection between the station "bus" bars and the underground system, thereby formally inaugurating the service of the first central station in the United States equipped for the commercial supply of current for light, heat and power through a complete system of underground conductors and interior wiring.

At the offices of Messrs. Drexel, Morgan & Company, on Wall street, were gathered a group of prominent financiers and enthusiasts centered around that interesting and original figure, Thomas Alva Edison. All were awaiting eagerly the "bursting into glory" of the incandescent lamps distributed throughout the offices, signaling the realization. at last, of the hopes and dreams of confident capitalists and enthusiastic disciples of the "wizard of Menlo Park."

To appreciate the enormous progress that has been made in industrial applications of electricity within the past 15 years, it may prove interesting and instructive to take a look into that historic station and examine the details of its electrical and mechanical equipment and compare them with the equipment of the station which we are invited to inspect this evening. No better idea of the status of the electric lighting industry at the time the Pearl street station was opened for service can be given than by quoting the following extract from the first annual report of the Edison company for isolated lighting, dated November 21, 1882:

"When this company was formed a year ago, the business of isolated lighting was entirely undeveloped, and no data existed whereby the future development of the business could be foretold. At that time Mr. Edison was making but one size of isolated dynamo, namely, the 'Z' dynamo (60 lights). We had no reliable steam engine; the innumerable details relating to installations, such as fixtures, safety catches and other appliances, were still unperfected, or were not manufactured on a suitable scale. There had been but eight isolated plants installed or in process of installation, and but one or two of them were in operation. We had no force of employés beyond a few connected with the New York office of the company, and but little preparation had been made for the development of the business. Such was the condition of the isolated business when the company was formed.

"One of the first things done by the company after its business had been systematized, was to take up the subject of procuring additional dynamos besides the 'Z' dynamos, also suitable engine. At a meeting of the board of directors, held January 26, 1882, the subject of additional sizes of dynamos was discussed and arrangements were made with Mr. Edison for the construction of experimental dynamos of additional sizes. The result was the production of two commercial dynamos in addition to the 'Z' dynamo, one being known as the 'L,' or 150-light dynamo, and the other as the 'K,' or 250-light dynamo. Arrangements are now being made for the construction of a still larger dynamo for isolated lighting, probably one of 350 lights. Regarding engines, great difficulty was experienced in obtaining an engine adapted to our especial needs."

To that time—October, 1882—the company had installed in all 123 plants, with a total of 21,998 lamps; among these were several of considerable size, and a few small central stations in country towns like Appleton, Wis., Shamokin and Sunbury, Pa., Brockton, Mass., etc., all of which were supplying current through overhead systems. Such was the state of the incandescent lighting industry when the Pearl street station was about ready for operation.

Fires were built under the boilers for the first time on June 29; the first dynamo was started July 5, and it was tested on a bank of 1,000 lamps in the station July 8. Then followed a period of tests and experiments which kept Mr. Edison and his assistants busy day and night, the public press meanwhile being filled with all kinds of wild rumors in explanation of the delay in lighting the district.

In examining the prominent features of this historic plant, we shall find, in one form or another, the essential elements of the best modern practice in central station construction. While it is true that some of the apparatus was crude and elementary in form as compared with present types, it amply demonstrates Mr. Edison's phenomenal anticipation of and provision for the broad lines which have made the Edison system so successful.

The station, as at first projected, occupied the premises 257 Pearl street; 255, which was to serve for future extension, being temporarily used as a store room and shops for the underground department. To prepare the building for the reception of machinery a heavy iron structure of girders and columns, not unlike the elevated railway structure, was set up, the boilers being below and the engines and dynamos resting on the girder platform above. The steam plant consisted of four Babcock & Wilcox boilers of 240 horse-power each, with the necessary equipment of steam pipes, heaters and feed pumps; coal and ash conveyers and a blower for forced draught completed the equipment and auxiliaries. The engine equipment, as originally planned, consisted of six Porter-Allen engines, $11\frac{1}{16}$ inches by 16 inches, each of which developed a maximum of 200 horse-power at 350 revolutions. The dynamos were of the old "Jumbo" type, one of the first examples of direct-connected slow-speed units, each having a capacity of 750 amperes at 120 volts when running at a speed of 350 revolutions per minute.

The conditions imposed upon the engines were so severe that but few engine builders dared attack the problem. High piston speed, close regulation, accurate balancing, limited space and great strength required to withstand the sudden applications of load made the use of the ordinary engine impossible. A number of types of engine were therefore especially developed for this work, at least two of which are still recognized in the market as standard types of construction. In the preliminary tests of the engines and dynamos while under load, unexpected difficulties developed in connection with the operation of the steam dynamos in parallel. There was a continual tendency to shift the load from one engine to the other, a seesawing of the governors and great variations of speed, accompanied by brilliant pyrotechnic effects that threatened the destruction of both engines and dynamos—a difficulty partially overcome by coupling the levers of the governors to a common rock shaft. Eventually Armington & Sims engines were developed, which completely solved this difficulty, and this type replaced several of the Porter-Allen engines.

The armatures of the "Jumbo" dynamos were 27 inches in diameter and 61 inches long, and each weighed nearly 10,000 pounds; the copper armature bars weighed 590 pounds and the armature disks 1,500 pounds. Each machine had 12 field magnets, of which eight were connected to the upper pole-pieces and four to the lower; the copper wire on the magnets weighed 1,500 pounds, and the total weight of the magnetic circuit was something over 33,000 pounds. The base plate weighed 10,300 pounds, the dynamo 44,800 pounds, the engine 6,450 pounds, making the total weight of the complete unit 61,550 pounds. The progress made in dynamo construction since these machines—which were considered marvelous in their day—were built is shown by comparison with a modern slow-speed multipolar dynamo, which, of approximately the same capacity, weighs only one-fifth as much, occupies but one-third the floor space and has a much higher efficiency. The "Jumbo" dynamos heated seriously and the commutators sparked viciously under full load, and it was necessary to use an air blast to keep the temperature down.

It will doubtless cause surprise to learn that the Pearl street station was started and operated for some time without a single voltmeter or ammeter; in fact, the station switchboard, the central keyboard from which the modern station is controlled, was altogether absent in this case. The dynamo and distributing switches, field regulators, etc., were located without any attempt at centralization. The voltage was maintained with fair approximation from the indications produced by an electro-magnet connected across the circuit, the armature of which carried a contact lever playing between high and low contacts, the pull of the magnet being balanced against an adjustable spiral spring. These contacts closed a relay circuit having a red and a blue lamp, the red lamp lighting when increased voltage gave the pull of the magnet the ascendency, and the blue lamp when the voltage dropped so as to give the spring the advantage. This apparatus was carefully graduated and adjusted by comparison with the electro-motive force of a standard battery at the Edison Machine Works on Goerck street, and I well remember carrying this by no means light apparatus back and forth on my shoulders for fear it might be thrown out of adjustment in transit. The station "bus" bars were built up of the half-round copper bars of the Edison two-wire tubes, and the main dynamo switches—ponderous affairs as big as hay cutters—established connection between the dynamos and the "bus." The "bus" bars extended to the Pearl street end of the station, and from this point copper lugs, carrying safety catches distributed the current to the feeders entering the Pearl street vault. The field regulators for each dynamo were built up of 40 or 50 large resistance boxes wound with strands of copper wire. They were so colossal that the regulators for the six dynamos, together with the connecting shaft and gear for operating the switch quadrants separately or together, took up nearly the entire floor above the dynamo room.

The underground system of mains and feeders—then of the two-wire system—had a length of about 18 miles and covered the territory extending from Wall street to Spruce and Ferry streets, and from Nassau street to the East River, which was known as the First District.

The Edison underground tubes for the two-wire system differed from the present type in having two conductors of nearly semi-circular section, instead of the three copper rods used in the three-wire system, and were separated by paraffined cardboard disks instead of spirally wound jute rope before filling with compound. The coupling joints of the 20-foot lengths were made of solid copper loops instead of stranded cable. At the time of laying the underground system, many of the tubes of large and small conductor section were bent by a special machine to the angle necessary to overcome the obstacles encountered in the streets, instead of using angle boxes, and many of the faults that developed in the early days were due to contacts in these bends.

In laying out the First District and determining the number and location of the feeders, a model of the district was prepared to scale, small spools, with resistances proportioned to the number of lamps, indicating the number of important installations. Wires, representing the system of mains, were drawn along the block faces and connected at the corners, thereby forming a complete network. The location of the feeder connections was experimentally determined by actually sending current into the spools and wires and locating, by actual measurements with a galvanometer, the most favorable points of connection to give an approximately uniform distribution of potential over the system.

Much of the interior wiring was cleat work, and I am sorry to say that the dangerous iron staple was also in evidence. Many of the first installations were equipped with wire having paraffined cotton braid insulation, but nearly all of this wire was replaced before current was turned on the system.

From the beginning, Mr. Edison considered the meter one of the essential elements of a system for commercial supply of current for light and power, and as soon as the station was started arrangements were made to introduce the Edison chemical meter. The first bills based on the amount of current consumed as shown by the meter were rendered after the station had been in operation a few months.

The Edison lamps in use at that time were of eight candle-power (two in series, of 50 volts each), 16 candle-power and 32 candle-power, with an efficiency of $4\frac{2}{3}$ watts per candle. On October 1, 1882—as stated, the station was started September 4—59 customers, having an installation of 1,284 lamps, were connected; this number was increased on January 1, 1883, to 231 customers, with 3,477 lamps connected, and wiring had been installed for 5,328 lamps.

At the time the First District was canvassed, great importance was attached to the probable use of current to operate electric motors, and a map

was prepared showing the location and capacity of all steam and power plants in the district. It was not until 1884, however, that motors were connected with the system.

The first arc lamp was connected to the system in 1883.

Such was the old and historic Pearl street station and the district it supplied, and such it continued, with slight additions and changes as experience was gained, and increased demand for current suggested improvements, until the time of the fire.

I will not ask you to accompany me further along the road of the development of the Edison Electric Illuminating Company of New York, although that road is dotted with the milestones of progress of the electrical industry. The history of that company covers the development of low-tension, direct-current central station practice, in which it has borne the brunt of the pioneer work.

Before proceeding with a description of this station, it may not be inopportune to give a few thoughts to the general problems involved in the modern station from an engineering point of view. The operations involved in the business of the supply of electric current from a central station for transformation into heat, light and power divide themselves readily into two broad divisions—generation, or manufacture, and distribution, or subdivision.

The generation, or manufacture, of current includes the cycle of operations conducted within the station itself, involves the transformation of the heat energy stored in the coal into dynamic energy, its transformation into electric energy and its delivery to the switchboard. The operations involved in the distribution of the current are effected mainly without the station, and involve its delivery through a network of mains and secondary conductors to the local centers of consumption, where, through translating devices, the current is transformed into the form of energy desired—light or dynamic energy.

The various processes involving the generation of electric current on a scale rendering possible its industrial utilization are, except where water power is available, the direct results of chemical action, usually the combustion of coal. The operations that a central station conducts are the economical burning of coal, the imparting of its heat energy to the water in the boiler, converting it into steam, the dynamic force of which impels the piston of the engine, resulting in the movement of conductors through the lines of force of an electro-magnet, thereby generating electric current.

Of the several steps of this cycle the important ones are mechanical. The economical burning of coal on a grate, although a chemical process, has been reduced by accepted types of boiler furnaces to a mechanical operation requiring some common sense and a stout arm, but no chemical formula. The electric generators involved are relatively simple, and the perfection to which electrical construction has already attained has confined further possibilities in this direction to improvements affecting the investment rather than operating accounts. I speak of this somewhat elementary proposition for the purpose of calling to mind and emphasizing the fact that in the modern central station the problems within the station—problems of generation or manufacture—are in mechanical rather than electrical engineering. The best types of multi-expansion condensing engines rarely transform more than 15 or 16 per cent of the heat energy of the coal into dynamic energy, and, in the common forms of non-condensing engines, not more than six per cent of the coal energy is available at the flywheel of the engine. Under the conditions found in most electric light stations these efficiencies can not be approached. Taking into account the variable loads on engines and boilers, condensation in steam pipes to the power required for the auxiliaries, with the other losses, the total efficiency of the transformation into electric current seldom, if ever, exceeds eight per cent, and is usually not greater than three per cent.

The electrical efficiency of the best types of dynamos of the size used in the larger stations is seldom less than 90 per cent, and, in the larger sizes, is as high as 96 per cent. These efficiencies diminish but little under the partial loads ordinarily carried in a well designed station having generating units of several sizes to maintain a high ratio of capacity to output. With the generators at this (Duane street) station it is possible to obtain a ratio of output to dynamo capacity in operation of 92 per cent between the hours of 9 A. M. and 6 P. M.; during the 24 hours this ratio is reduced to an average of 85 per cent, as the smallest unit available has a capacity considerably in excess of the requirements during the minimum hours.

It is safe to say that, of the energy delivered to the engine shaft, from 75 to 85 per cent in the smaller stations, and from 85 to 90 per cent in the larger, is delivered as electrical energy to the switchboard, including losses due to the inefficiency of the dynamos, in the leads to the switchboard, in the contacts, etc. It is evident, therefore, that the losses due to the inefficiency of the electrical apparatus in the station are small as compared with those due to the inefficiency of the apparatus engaged in the conversion of heat energy into dynamic energy, and, in the auxiliary apparatus, the great problem in the mechanical operation of a station is to reduce these losses to a minimum, approaching as nearly as possible the conditions of maximum economy—the coal consumption, per unit generated approaching what its value would be if the whole station were operated at the load of maximum efficiency for the 24 hours.

The problems which are more specifically electrical in their nature are those connected with the delivery of the current from the switchboard into the system of mains and feeders which distribute the current to the consumer's premises and its transformation there in the form of energy desired. I will not undertake to point out here the numerous methods available for effecting this end, but will confine myself strictly to the system under consideration.

The loss of energy in the conduction of current from the switchboard to the point of consumption depends upon the factors, current, pressure, sectional area of conductors, and their length. For each particular case there exists a fairly definite relation, from which, given the cost of producing the current, the average use of current, or the load factor, the distance to the point of consumption, and the cost of the conductor per unit area, the most economical section can be determined. It would, of course, be out of the question to make this calculation for each consumer, or group of consumers, but it must be taken into account when it is a question of supplying current at considerable distances from the station. Erroneous ideas are held as to what the actual losses are in a network of feeders, mains, and services distributing current from an Edison station. It may be interesting to note that the drop of voltage, due to resistance of conductors between the switchboard and the consumers' services on the Edison system in New York, amounted to an average of seven per cent during 1895. To this should be added an average drop of two to two and one-half per cent on the consumers' wiring between the service and the lamps. This drop has been reduced considerably, as well as the investment cost for conductors, by the use of two or three "bus" pressures in the modern station, grouping the distant, or heavily loaded, feeders on the "bus" carrying the high voltage, and the short, or lightly loaded, feeders on the low "bus." The same result is obtained by the use of a "booster" inserted in series with the feeder, which adds to the "bus" pressure the voltage necessary to overcome the drop.

Notwithstanding the much-talked-of leveling of the station load curve due to the installation of motors, it will be found that as a station increases in capacity the ratio of maximum load at any time to the total connected installation will continue to fall. There is a limit, of course, beyond which this decrease is not likely to go, depending largely on the further uses to which electricity will be applied.

In an industrial district, where the motor load is heavy nearly all day, the lighting load is comparatively light, except during the Winter, when darkness sets in early, and the motor and lighting loads overlap. In a district of this kind, moreover, there is but small demand for light at night. In a residential or shopping district, on the contrary, the motor load is of less importance and the lighting load becomes great immediately upon the approach of darkness, reaching a maximum in the evening and extending some into the night.

These characteristics are clearly shown by the two curves of the diagram before you, one representing the load of the First District, extending from the Battery to Fourth street, the other, the load of the Second District, extending from Fourth street to Eightieth street on the east side. In the First District, motors represent nearly 42 per cent of the total installation, and the output to motors during last year was nearly 45 per cent of the total output of the district. The ratio of maximum load at any one time to connected installations varied from 21 per cent in Summer to 38 per cent in Winter, the load factor—the ratio of average load to maximum load—averaging about 26 per cent during the entire year. In the Second District the motors represent only 17 per cent of the total installation, and the current delivered to them during the year represents only 16 per cent of the total output of the district. Yet the percentage of maximum load to connected installations varies from 16½ per cent in Summer to 38 per cent in Winter, while the load factor exceeds an average of 30 per cent—more than four per cent higher than the average of the First District.

It is interesting to note that the daily average use of each incandescent lamp installed is almost identical with the daily average use per rated horse-power of motors installed. This fact, if taken alone, would be misleading; it should be remembered that an incandescent lamp is used at its full candle-power, whereas the current consumed by the motors will average less than one-quarter or one-third of their rated capacity.

Although motor service is, on the whole, advantageous to a station, owing to the long average use in proportion to the time of maximum current demand, and can, therefore, be sold at a considerably lessened rate than in the case of arc or incandescent lighting, it is not an ideal service. This is due to the fact that the motor load overlaps the period of maximum demand for lighting, and, therefore becomes part of the maximum load on the station, for which generating and distributing capacity must be provided. The ideal service for leveling the load curve, which all station managers are striving to do, is one which ceases before the time of maximum lighting, and which would not, therefore, call for additional and special investment. It is hoped that some such application may appear in the many uses which are being found from time to time for the electric current.

Additional Exhibits: 4. Comparative output of London, Berlin and New York Edison stations. 5. Characteristic output curve of each month of the year. 6. Curve of monthly variation of maximum, average and minimum loads. 7. Loads on special days: Christmas, Fourth of July, heaviest load during year, etc.

Owing to Mr. Lieb's illness, the part of the paper referring specifically to the Duane street station was not finished. Mr. R. R. Bowker, first vice-president of the company, addressed the meeting, pointing out the characteristic features of the station construction and equipment.

Customer and Salesman.

To the Editor of Electrical Review:

Referring to your editorial, "One Way of Selling Goods," it strikes a responsive chord in me, as I have been there—in a late order for considerable machinery, both electrical and steam, in which some half a dozen concerns got bites of the cherry. Just one concern, and only one, tried to make a good job first and then collect; the others dumped their stuff in the cellar and then began to talk of how soon could they get their money (we rate a million and over). None but the one firm referred to seemed to care a fig about keeping to their signed contracts. To them a contract was waste paper, but it was very handy to remind us about terms of payment, etc. I think a pamphlet entitled "First Principles of Business" ought to have a very active sale among a large number of electrical and steam concerns.

Yours truly,

Plain Business.

New York, March 4, 1896.

Cut Off the Chimney or Raise the Wires.

One of the many difficulties encountered by the telephone man is thus related in a recent issue of the Barbadoes, British West Indies, *Advocate*:

The abnormal length of the smoke stack of the small engine which hauls the penny train on the Barbadoes Railroad is causing some amount of trouble to the trainmen and delay in the running of the train. On Tuesday morning the locomotive had to slow down three times between Windsor and Bridgetown whilst one of the men raised the overhead telephone wires to enable the chimney to pass under them. This proceeding caused much amusement and comment amongst the passengers. It is clear that either the chimney is too tall or the wires too low.

Standard Rules For Electrical Construction.

To the Editor of Electrical Review:

On behalf of the Committee of Standard Rules for Electrical Construction and Operation, of the National Electric Light Association, I write to state that after mature deliberation it has been decided to extend an invitation to the Underwriters' National Electric Association to send a delegate to the joint conference to be held on March 18 and 19. This association has been added to the list of 11 organizations already co-operating, which was published in a recent issue of your journal. Our committee was led to this action, which has been under consideration for some time past, by reason of the fact that they felt that while the insurance interests of the country would be ably taken care of by the representative of the National Board of Fire Underwriters, and although they realized that the Underwriters' National Electric Association, acting merely in an advisory capacity, being composed of the electrical inspectors from all parts of the United States, and having no authority in itself as an association, so closely were they identified with the preparation, endorsement and enforcement of rules for electrical construction and operation, and so alive to the practical questions which would come before the joint conference, that the committee felt it advisable to extend an invitation to their organization to send an official delegate on the same par with the 11 other interests already invited.

I append herewith a list, which has been prepared, of complimentary delegates to be invited to the joint conference in an advisory capacity, but solely as individuals and not as representing any association or manufacturing interests. These gentlemen, by reason of their experience, the nature of their occupation, their identification in the past with work such as the proposed joint conference will consider, together with their prominence in electrical engineering matters, have been considered by the committee as likely to lend valuable advice and additional strength to the joint conference: Wm. MacDevitt, Inspector Board of Fire Underwriters, Philadelphia, Pa.; A. E. Kennelly, consulting engineer and expert, New York; W. J. Jenks, electrical engineer and expert, New York; A. H. Henderson, Chief Inspector Fire Department, New York; Morris W. Mead, Superintendent Bureau of Electricity, Pittsburgh; Prof. Wm. A. Anthony, consulting engineer; E. H. Johnson, New York; S. E. Barton, New York, and E. V. French, Inspector Factory Mutual Fire Insurance Company, Boston.

The committee has in preparation a transcript of the various codes most extensively in use, and this, in a convenient and compact form, will be in the hands of each delegate prior to the meeting, at which meeting a large amount of additional matter bearing upon American and European practice will be available, and it is the intention that, in the consideration of the various rules presented at the joint conference, the decision as to what shall be adopted for the national code will be governed solely by the law of the "survival of the fittest." Yours very truly,

Wm. J. Hammer,
Chairman Committee, National Electric Light Association.
New York, March 6.

General Electric Again Secures Control of the Boston Edison Company.

The General Electric Company has again secured control of the Edison Electric Illuminating Company of Boston, according to a report current in New York last Saturday. This report was based on a letter which had been received by James W. Godfrey, manager of sales for the India Rubber and Gutta-Percha Insulating Company, to the effect that, as the General Electric Company had secured control of the Edison Electric Illuminating Company of Boston, the India Rubber and Gutta-Percha Insulating Company was requested to remove the stock of wire and reels which it had placed on consignment with the Boston Edison company.

It was also reported last week that the General Electric Company had secured control of the Syracuse, N. Y., Electric Light and Power Company.

The Garvin Machine Company Again Burned Out.

The six-story building at Laight and Canal streets, New York city, occupied by the Garvin Machine Company, well known manufacturers of machine tools, was completely destroyed by fire early last Friday morning. This company has been especially unfortunate in its experience with fire. During the great blizzard of 1888 its building was burned, and a month ago the same building was damaged to the extent of $25,000 by fire. Garvin's building, as well as the one adjoining, were burned last Friday, the total losses amounting to $136,000. It is understood that the Garvin Machine Company was fully protected by insurance. The company immediately secured temporary offices at 96 Canal street, from which address its business will be transacted for the present.

The Cost of Calcium Carbide.

[From the Engineering and Mining Journal.]

The Spray works in North Carolina, which we were told could make calcium carbide at $5 to $7 a ton, now have got down to the point of quoting it at five cents per pound ($100 a ton), and claim to be able to supply 400-pound lots. One would suppose they would not throw it away here at about half its advertised market price in England.

At even $100 a ton for absolutely pure calcium carbide—which none of it is—acetylene would cost about $250 a ton, as against $15 a ton for petroleum naphtha for enriching illuminating gas. The danger of handling and using acetylene is also becoming better known and is a very serious drawback.

ELECTRICITY FROM COAL.

A PROCESS DESCRIBED IN A PATENT ISSUED TO PROF. W. W. JACQUES, OF BOSTON.

A number of attempts have been made to employ coal or carbon as a soluble element of a chemical battery for the production of electricity. All these attempts have, however, proved uncommercial by reason of great expense attending the chemicals employed. The familiar apparatus of Jablochkoff was the prototype in this art. Jablochkoff employed a cast-

Fig. 1.

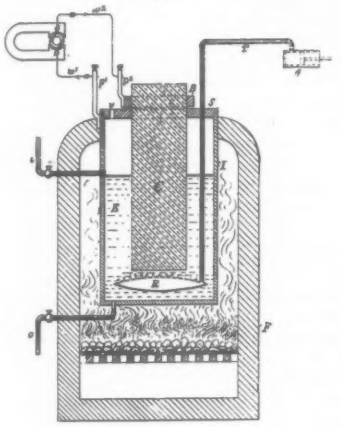

Fig. 2.

Electricity Direct From Coal.

iron vessel, which formed one of the electrodes, and in which was maintained in fusion nitrate of potash or soda (saltpeter), a stick of carbon forming the positive or soluble electrode and a body of carbon held in an iron basket. The melted nitrate gives up oxygen to the carbon, creating a slow combustion, which generates the electric current.

Another battery of this type has been recently made a subject of patent to W. W. Jacques, in which it is proposed to employ caustic soda. A feature of difference, however, exists in the circumstance that the soda vehicle is to act as a carrier for the oxygen of the air which is forced through the fused soda. An iron vessel is employed as container and a suitable heat to maintain the soda in fusion about 900 degrees Fahrenheit is provided by the fire applied to the iron vessel. The apparatus in which the process is carried out is illustrated in the accompanying engraving, in which I is the containing vessel of rolled Norway iron suitably supported within a furnace containing carbon electrode and a device for aerating the liquid shown as a pipe with numerous small holes beneath the carbon. In the specification of the patent it is said:

"It is desirable in order to facilitate the chemical action, and consequently obtain a more considerable current of electricity, to thoroughly impregnate the electrolyte with oxygen, and this may be done by admitting the air under pressure in a considerable number of fine sprays. It is also desirable to maintain a constant circulation of the electrolyte, so that new portions, freshly charged with oxygen, may successively be brought in contact with the carbon. Such circulation is well obtained by the ebullition into which the electrolyte is thrown by the admission of air under pressure. Again, it is desirable, in order to prevent the setting up of electro-motive forces opposed to the proper electro-motive force of the generator, to keep the whole body of the electrolyte and the contained carbons and containing-vessel, used also as a collector, at a more or less uniform temperature throughout, and this is conveniently done by the ebullition due to the air forced in. Again, the constant ebullition of the electrolyte removes from the surface of the consumed carbon such ash and other products of chemical action as may form upon it, thus leaving fresh surfaces of carbon continually exposed to the action of the electrolyte." * * * *

"Although the greater part of the carbonic acid, whether resulting from the union of carbon and oxygen or already existing in the air supply, bubbles up through the electrolyte and escapes, a portion of this carbonic acid combines with a portion of the caustic soda to form carbonate of soda, and this, together with the ash from the carbon, slowly contaminates the electrolyte, and in the course of time lessens its efficiency. The efficiency of the generator may, however, be maintained by drawing off from time to time a portion of the contaminated electrolyte and admitting a fresh portion to take its place."

Meeting of Electrical Manufacturers.

A meeting of electrical manufacturers was held at the Astor House, New York, last week to consider the question of organization for mutual benefit. Messrs. C. M. Wilkins, of Partrick & Carter; A. Bournonville, of Alfred F. Moore, and C. E. Trump, of the Novelty Electric Company, of Philadelphia, were present and gave an account of the successful organization of the Electrical Trades Association of their city. After considerable discussion it was voted to form an association, and a committee of five was appointed by the chairman, Mr. W. J. Johnston, which met on Tuesday of this week to arrange details. The committee named were Messrs. Gallaher, Gilmour, Geddes, T. J. Smith and Price.

The meeting was attended by the following gentlemen, representing the houses named: Messrs. Eugene F. Phillips and P. C. Ackerman, of the American Electrical Works; R. E. Gallaher, New York Insulated Wire Company; Geo. T. Manson, Okonite company; T. J. Smith, E. S. Greeley & Company; A. P. Eckert, Safety Insulated Wire and Cable Company; J. J. Gorman, Manhattan Electrical Supply Company; C. L. Smith, Union Porcelain Works; E. A. Lowe, J. Jones & Son; J. B. Peck, W. R. Ostrander; C. P. Geddes, Interior Conduit and Insulation Company; E. R. Gilmour, Western Electric Company; B. M. Downes, Bushwick Glass Works; J. P. Marshall, John A. Roebling's Sons Company, and the representatives of the electrical press. Mr. A. P. Eckert was elected secretary of the meeting.

Mexican Street Railways Sold.

C. F. Meek, of New York, on March 5 purchased the street railway lines in the City of Mexico, comprising about 160 miles, and resold them to Henry Butters, of San Francisco. The price is understood to be $7,500,000 (Mexican). Butters is reported to be backed by London capitalists. The lines are to be equipped with electricity and other improvements, involving an amount that will be equal to the purchase money. Mr. Meek was formerly prominently connected with the Union Pacific Railroad Company and is well known among electrical men.

ADVANCE INFORMATION

Valuable News and Tips for Manufacturers and Dealers.

We publish below information relating to new electric railways, new electric light companies, new telephone companies and projected electric construction of all kinds. Every reader will find these columns of special interest, and manufacturers and supply houses will receive many valuable suggestions looking to new business by carefully watching this department in the ELECTRICAL REVIEW.

Electric Light and Power.

CORDELE, GA.—The Citizens' Electric Light and Power Company has been incorporated by E. C. Patterson, O. E. Ringland and others, for the erection and operation of electric plants. Capital stock, $10,000.

LOUISVILLE, N. Y.—St. Lawrence Power Company has been incorporated by Michael H. Flaherty, H. H. Warren, Charles A. Kellogg, Charles B. Higgins and Albion Mann, to develop and to furnish hydraulic and electrical power, etc. Capital stock, $200,000.

BONHAM, TEX.—The Bonham Electric Railway, Light and Power Company has been formed. It purchased the electric light plant and will more than double the capacity of same.

BRIDGEPORT, ALA.—George Jenkins is interested in the establishment of an electric light plant.

LEWISTON, IDAHO—Lewiston Light Company, Limited, has been incorporated by W. A. Smith, S. H. Reed, D. M. White, W. F. Kettenbach, B. F. Morris, A. W. Krontinger, Oscar Peterson and F. W. Kettenbach. Capital stock, $10,000.

PORTLAND, ME.—Ecuador General Electric Company has been incorporated with Henry J. Ryan, president; W. Boardman, treasurer; to supply gas or electricity to Guayaquil, Ecuador, South America. Capital stock, $100,000.

CHILLICOTHE, MO.—An electric light plant is to be established by the city. Bids are being invited by Oscar L. Smith, city clerk, until March 1, for lighting the streets with electricity for five years.

WEIMAR, TEX.—Frank Leidholf will erect an electric light plant.

MT. CLEMENS, MICH.—The Mt. Clemens Electric Light Company has been granted permission to increase its capital stock to $60,000.

SANBORN, IOWA—An electric light plant is to be established here.

HOLLIDAYSBURG, PA.—An electric light plant is to be established here at a cost of $15,000.

EAST FAIRFIELD, VT.—It is reported that an electric light plant is to be established here.

GALLATIN, TENN. — An electric light plant is to be put in at this place, to be operated by the town, which will issue $5,000 worth of six per cent bonds for that purpose. Work will be begun on this new enterprise soon.

COLTON, CAL.—The contract for building an electric plant in Colton has been awarded to Wilcox & Rose, of this city.

WINONA, MINN. — The electric lighting and street railway plants of the Winona General Electric Company will be sold on April 13.

ALAMEDA, CAL. — The Stanley Manufacturing Company has been awarded the contract for placing the 250-kilowatt dynamo in the municipal electric light plant.

SOCIAL CIRCLE, GA.—An electric light plant will be established here shortly. J. L. Watkins is interested.

EUFAULA, ALA.—Bonds to the amount of $75,000 will be issued for waterworks, sewerage and an electric light plant.

JACKSONVILLE, FLA.—Le Bourveau & Company, the electrical firm of this city, have just secured the contract for the furnishing of a 1,000-light Royal alternating dynamo and other station equipment from the Lake City Water and Light Company.

COMPTON, NEB.—The Compton Irrigation and Power Company has been incorporated. The capital stock is $5,000 and the incorporators are Thos. Dentler, S. B. Bivins, George H. Shiek, Harry Dentler and John H. Evans.

DULUTH, MINN.—The business of the Hartman General Electric Company has been transferred to the Commercial Light and Power Company, and will hereafter be transacted under the latter name. It is no change, except in the line of development, most of the old officers and directors remaining. The company increases its capital stock to $1,000,000.

ALBANY, N. Y.—The Richmond Hill & Queens County Gas Light Company has been incorporated by Alexander A. Forman and Reinhold C. Boeklyn, of Brooklyn; E. S. Hobbs and F. B. Case, Jr., of New York, and James G. Forman, of Haverstraw, to make and sell illuminating and fuel gas and to generate and supply electricity for the villages of Richmond Hill, Jamaica, Brooklyn Hills, Woodhaven and adjacent territory. Principal business office, New York city. Capital stock, $250,000.

CHARLOTTESVILLE, VA.—The Massir Light and Power Company has been incorporated with W. J. Ficklin, president, and others. Capital stock, $50,000.

MANKATO, MINN.—L. E. Watkins, of Boston, has been awarded contract to light the city of Mankato by electricity and to operate within four years an electric street railway five miles in length.

SAN FRANCISCO, CAL.—Oleta Canal and Power Company has been incorporated by D. R. Thomas, W. M. Swett, L. P. Thomas, F. A. Berlin and B. W. Thomas. Capital stock, $1,000,000.

GILLETT, COLO.—A new $25,000 electric light plant will probably be erected.

New Electric Railways.

CRIPPLE CREEK, COLO.—Electric Tramway and Tunnel Company has been incorporated with C. M. Rice, president; W. E. Bridgeman, secretary. Capital stock has been increased from $1,250,000 to $2,000,000.

IPSWICH, MASS.—An electric street railway is to be constructed, and special franchise for same has been secured.

GREEN BAY, WIS.—The Fox River Electric Railway Company has obtained control of the McCartney line as the outcome of negotiations that have been pending for some time.

VICTOR, COLO.—William S. Jones, of St. Louis, and others will ask for a franchise to construct an electric street railway.

ALBANY, N. Y.—The Yonkers & Tarrytown Electric Railroad Company has been incorporated by James M. Edwards, John R. Ingram, Frederick B. Hawley and others, to operate a street service railroad 13 miles long, from Yonkers to Tarrytown. Capital stock, $750,000.

PHILADELPHIA, PA.—A contract to supply trolley cars for the Cape Town Tramway Company, of South Africa, has been received by J. G. Brill & Company, of this city. The line over which the cars are to run is now in course of construction, and will be the first trolley road in Africa. Brill & Company will erect the power house and furnish all the auxiliary engines, motors, etc. The poles and wires will be furnished by other United States firms.

LEXINGTON, KY.—The Belt Line Electric Company has about decided to extend the East Main street car line to the reservoir. Work will probably be begun on laying the track about May 15.

MONROEVILLE, OHIO—Plans have been completed for the building of an electric railway between this town and Sandusky.

NEW LONDON, CT.—The New London Street Railroad will erect a $60,000 brick building on Shaw's cove. The building, which is to be used by the company as a power house, will have every modern appliance for generating electric power.

DETROIT, MICH.—J. R. McDonald, of this city, and his associates in New York have bought the Milwaukee & Wauwatosa Motor Railway Company. The new organization proposes to make it an electric line, running through North Greenfield to Waukesha.

BALTIMORE, MD.—The contract for the steam plant of the power house of the Baltimore, Middle River & Sparrows Point Electric Railway Company, near Back River, has been awarded to the S. Davies Warfield Manufacturing Company.

BALTIMORE, MD.—The Columbia & Maryland Electric Railway granted permission to construct tracks through Hyattsville.

GRAND RAPIDS, MICH.—Frank D. Prindle and W. J. Gage are organizing a stock company to construct and operate an electric railway parcel delivery system in this city.

AKRON, OHIO—The Akron & Cuyahoga Falls Rapid Transit Company will construct an electric road to Cleveland, to compete with the Akron, Bedford & Cleveland line.

DETROIT, MICH.—An electric line will be constructed to Ann Arbor from Detroit.

SPENCER, MASS.—The Warren, Brookfield & Spencer Electric Road has been granted charter for new electric road, and the Worcester Construction Company has been awarded contract for building same.

SOUTHBRIDGE, MASS.—The Southbridge & Sturbridge Street Railway Company has been incorporated by Thos. J. Robinson, Geo. W. Wells, Calvin D. Paige, Chas. W. Hill and F. L. Chapin to build an electric railway. Capital stock, $60,000.

HARRISBURG, PA.—The Chester & Marble Electric Railroad Company, of Delaware County, has been incorporated with Warner H. Jenkins, president, to construct an electric line. Capital stock, $72,000.

GAINESVILLE, FLA.—A franchise has been granted to Messrs. Graham, Cole and Taylor for operating an electric light and street railway plant.

New Manufacturing Companies.

BALTIMORE, MD. — The Autographic Telegraph Company has been incorporated with a capital stock of $1,000 by Edwin F. Abell, Michael Jenkins, Richard Cromwell, B. F. Deford and Arthur Steuart, for the purposes of manufacturing and dealing in all kinds of electrical machinery for light, heat, power, locomotion, telephony, telegraphy, etc.

TROY, N. Y.—The Windsor Brake Company has been incorporated to manufacture emergency and safety brakes for street railway cars. Capital, $10,000. Directors, Daniel Gaffney and Morris Levy, of Troy; John T. Gorman, of Cohoes, and John Gibbons, of West Troy.

NEW YORK, N. Y.—Fortosec Battery Company has been incorporated by J. C. Chapin, W. A. Pollock, New York; Chas. H. Shaw, D. N. Maxon, Brooklyn, N. Y.; to manufacture electric supplies, etc. Capital stock, $1,000,000.

WINCHESTER, KY.—The Novelty Manufacturing Company has been organized to manufacture electrical and mechanical specialties, etc.

CHICAGO, ILL.—Farr Telephone and Construction Supply Company has been incorporated with a capital stock of $10,000 to manufacture telephones. Incorporators, Kenneth R. Smoot, Clarendon B. Eyre and M. E. Shea.

New Telephone and Telegraph Companies.

KEY WEST, FLA.—The Key West Ocean Telegraph and Telephone Company has just been organized with a capital stock of $25,000, with privi-

leges of increasing it to $500,000, for the purpose of constructing, owning and operating ocean and overland telegraph and telephone lines from Key West to Jupiter, in Dade County, running through the counties of Monroe, Dade, Lee and DeSoto, a distance of about 1,000 miles; also telegraph and telephone lines in Key West. The president of the company is William D. Cash, a wealthy and prominent merchant; Ben McLendon, secretary, and W. B. Curry, treasurer.

BANGOR, ME.—The lines of the New England Telephone and Telegraph Company in the eastern and central portions of the State will be improved and extended as soon as the frost is out of the ground.

Increase of Capital.

ALBANY, N. Y.—The Albany Street Railway Company will increase its capital stock to $500,000, and will extend its electric railway.

ROCKFORD, ILL.—The Rockford City Railway Company has increased its capital stock from $150,000 to $200,000.

Business Troubles.

MADISON, WIS.—The Madison City Railway has been placed in the hands of F. W. Oakley, of Madison, as receiver. The suit is to foreclose the first mortgage bonds, amounting to $150,000, for the holders.

LITERARY.

We have received Vol. 1, No. 1, of the "Journal of the Western Society of Engineers," of Chicago.

James Gordon Bennett has reduced the price of the New York *Evening Telegram* from two cents to one cent.

We are just in receipt of the 1896 issue of Dauchy & Company's Newspaper Catalogue. This work is issued annually, and has become so familiar to advertisers, newspaper publishers and others who are interested in the periodical publications of the country, that it hardly needs extended notice from us. It is no faint praise to say that this edition is fully up to those of previous years. The book is a large volume of 710 pages, well bound in cloth, carefully printed from large and clear type, and on heavy paper, so that, mechanically, nothing better could be desired. The statistics are very conveniently arranged, and the peculiar feature of a ruled space for memoranda against each paper makes this catalogue the most useful one published. Advertisers and others who have occasion to use a newspaper directory regularly know how necessary it is to make memoranda as to contracts, changes, etc., against the names of the papers, and this is the only work in which a space is provided for this purpose. This newspaper catalogue is a credit to its publishers, Messrs. Dauchy & Company, 27 Park Place, New York, from whom it can be obtained.

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KINDRED INTERESTS

A good opportunity to purchase a promising electric light and power plant is offered in another column of this issue of the ELECTRICAL REVIEW.

The Voltak Supply Company, 521 West Thirtieth street, New York city, are introducing a dry, soluble compound for zinc carbon batteries, which they say costs about half as much as the solution, and, aside from its convenience, adds life and safety to the battery.

The Jewell Belting Company, of Hartford, Ct., are noted for their up-to-dateness in all matters pertaining to power transmission by belts. They have on the market the Jewell pulley covering, which is fully guaranteed to prevent the slipping of belts. It is described in a catalogue, which may be had on application.

Mr. John L. Somoff has removed from 11 Park Row, New York city, and in future will be connected with the Standard Electric Lamp and Novelty Company, 248 West Twenty-third street, in the capacity of electrician. This company has recently been organized to manufacture miniature incandescent lamps and electrical specialties.

The New England Electric Supply Company, of 49 Federal street, Boston, Mass., have secured the exclusive New England agency for the Crocker-Wheeler Electric Company's dynamos and motors, the sale of which they propose to push vigorously. The agency for these well known goods is an important acquisition for this young concern.

The Dudley Electric Manufacturing Company, 81 New street, New York city, speak most encouragingly of the success which they are having in the introduction of their individual telephone signal. Mr. G. W. Andrews, general manager of this company, has been spending some time in the South making experiments with this instrument for certain telephone companies.

The Gordon-Burnham Battery Company, 82 West Broadway, New York city, has had most marked success in the introduction of the Gordon primary battery during last season. This company has been pushing the battery in the electrical field but a comparatively short time, yet it has already been adopted by many of the largest telephone companies, railway companies and fire-alarm systems in the country. Its peculiar combination of longevity and efficiency makes it a particularly satisfactory battery.

The Metropolitan Electric Company, of Chicago, report recent large sales of P. & B. tape and compound. The Spring construction has begun rather early. These goods are found to be as reliable as of old. The Metropolitan Electric Company are fortunate in having this agency, and have increased the business West, since it has been in their hands, very considerably. They are also having some splendid orders for Ship cored carbons, another specialty of the Standard Paint Company, for which the Metropolitan Electric Company are western agents as well.

The success which the Scientific Machinist Company, of Cleveland, Ohio, have had with their method of practical instruction for electrical students is proving the value of learners having, in addition to the theoretical teaching, experience with actual electrical and machinery construction. This school, in addition to their system of instruction by mail, send their electrical students various parts of dynamos for construction, armatures for winding and the separate elements of a machine for study. In this manner the beginner has an opportunity for practical demonstration, which aids materially in grasping theories while they are being taught.

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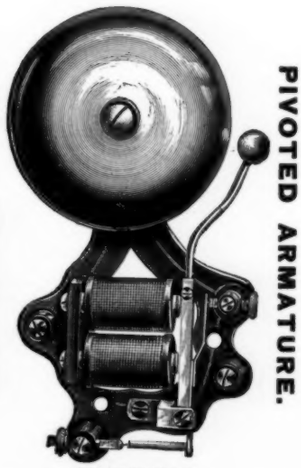
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ELECTRICAL PATENTS

ISSUED MARCH 3, 1896.

555,487 555,488 Closed conduit electric railway; C. Anderson, Leeds, Eng.

555,491 District alarm system; M. E. Barrett, Chicago, Ill.—A pair of limbs connected in a circuit with a battery, a plurality of parallel branches between said limbs, each of said parallel branches comprising the contacts of a relay, a register, and the magnet of a second relay, and a conductor connecting two or more of said branches at points between the register and the magnet of the second relay.

555,503 Controlling mechanism for electric motors; L. Y. Gibbs, Milwaukee, Wis.

555,509 Electric railway; R. M. Hunter, Philadelphia, Pa.

555,511 Method of converting potential energy of carbon into electrical energy; Wm. W. Jacques, Newton, Mass.—Consists in chemically combining oxygen with said carbon or carbonaceous materials through an intervening electrolyte.

555,529 Motor hanger for electrically propelled cars; E. Peckham, New York, N. Y.—An electric motor pivotally connected at one end to the axle of the truck, longitudinal motor hangers pivotally connected between their ends to the sides of the motor and supported at each end from the frame of the truck.

555,544 Dynamo-electric machine and electric motors; G. A. Welles, New York, N. Y.—A single coil multipolar magnet, provided with arms radiating from the core at either side of its coil, and terminating with U-shaped pole-pieces alternating in sign and lying in a plane concentric with the axis of the machine, to thereby co-operate with an armature constructed to register therewith and be embraced between the opposite faces of the U-shaped pole-pieces.

555,546 Electro-magnet for separating metals; H. H. Whiteacre, Wellsville, Ohio.

555,581 Engraving machine; B. S. Molyneux, Minneapolis, Minn.—Consists of a graver or drill, an electric motor, with the motor armature and the drill on a common shaft which is free for sliding movement in fixed bearings.

555,585 Safety appliance for electric brakes; W. B. Potter, Schenectady, N. Y.—Comprises a brake-switch, brake magnets and a source of electro-motive force in circuit with the braking switch and means controlled by the current in the circuit for preventing the too rapid manipulation of the brake switch.

555,589 Electric meter; G. A. Telge, Oldenburg, Ger.—Comprises a pair of synchronous indicators, and a device under control of the current to be measured, having oppositely working regulating connections with indicating mechanisms for adjusting them simultaneously in opposite directions and thus differentiating their readings proportionately to the controlling current.

555,590 Monocyclic generator; E. Thomson, Swampscott, Mass.—A main armature generating single-phase alternating current, an auxiliary armature comprising a winding upon a separate core from the main armature, but mechanically connected with the main armature and generating an electro-motive force of displaced phase, and a connection between the teaser armature and the main armature.

555,601 Electrical railway signal; W. Fiedler, Charlottenburg, Ger.

555,621 Electric arc lamp; R. Schefbauer, Hoboken, N. J.—Consists of carbon holders and their racks, a cross shaft and pinions acted upon by the racks, a ratchet wheel, a flywheel and pawl loose upon the shaft, a magnet in the main line, a rocking lever connected to the core of the main line magnet, a clamp and a link acting upon the clamp to move the flywheel and draw the arc.

555,626 Facsimile telegraphy; A. W. Storm, Ramsey, N. Y.

555,628 Armature for dynamo and motors; G. A. Welles, New York, N. Y.—Built up in segmental sections and provided with coils so placed thereon that spaces are left on the outer periphery thereof, together with a circular retaining ring secured at one side of said armature and provided with fingers arranged to enter said spaces whereby the segmental sections are held and secured together.

555,634 Trolley protector for firemen; J. P. Barrett, Chicago, Ill.

555,645 Telephone call register; H. Hempel, Berlin, Ger.

555,674 Trolley head; G. W. Blackburn, Columbus, Ohio.—Consists of a trolley head provided with a socket adapted to receive a threaded pole and carrying the trolley-carrier.

555,702 Electrical measuring instrument; A. H. Hoyt, Penacook, N. H.—Consists of a stationary member, a movable member, a spring arm forming the sole support and guide for said movable member, and a pointer connected with said movable member and adapted to travel over a graduated scale.

555,707 Signaling circuit; J. J. O'Connel, Chicago, Ill.

555,725 Party telephone line apparatus; A. S. Hibbard, Chicago, Ill.

555,794 Magnetic separator; J. P. Wetherill, S. Bethlehem, Pa.—Consists of an ore conveyer, an electro-magnet located above and in near proximity to its conveying surface, said magnet having tapering pole-pieces transverse to the direction of movement of the core, and an inclosing frame of non-magnetic material for the pole-pieces, the same being adjustable within the frame.

555,800 Electric railway system; A. J. Beitzel, Boiling Springs, Pa.

555,832 Electric coal cutter; I. E. Storey, Boulder, Colo.—Consists of a motor and its shaft, a counter shaft passing between the field magnet coils, bevel pinions carried by the counter shaft, a bevel gear with which said pinions are adapted to engage, a cutting chain driven by said gear and a feeding mechanism driven by said counter shaft.

555,841 555,891 Electric arc lamp; T. E. Adams, Cleveland, Ohio.

555,846 Bond or connector for electric railways; A. Bournonville, Philadelphia, Pa.—A bond half-round in cross-section, having an end portion reversed on itself, producing a divided head, and a wedge adapted to spread apart the sections of said head.

555,847 Timing apparatus; G. F. Brackett, Jersey City, N. J.—Consists of a time movement, time movement stop mechanism, separate time movement start mechanism and alarm mechanism actuated respectively by the operation of the time movement.

555,850 Core and coil for dynamo-electric machines. 555,899 Armature for induction motors; A. L. Cushman, Concord, N. H.

555,851 Armature for induction motors; A. L. Cushman, Concord, N. H.—A laminated core and separate and distinct windings consisting of multiple closed-circuit coils and short-circuit coils closed in series, all arranged in such relation one to the other as to produce unsymmetrical polarities upon said armature.

555,862 Electric railway brake; J. C. Henry, Westfield, N. J.

555,895 Method of and apparatus for treating electrical conductors; C. E. Carpenter, Bridgeport, Ct.—Consists in first shaping the conductor, then placing the same upon a supporting body, then heating the conductor until it becomes limp or inelastic and then allowing the conductor to cool.

The "Baby" Knife Switch has leaped into public favor with about the same rapidity that the new "baby" usually does. The Electric Appliance Company, of Chicago, is meeting the demand for this new specialty by carrying a large stock at very low figures. It is furnished in round or square bases, in 15 and 25-ampere single and double pole.

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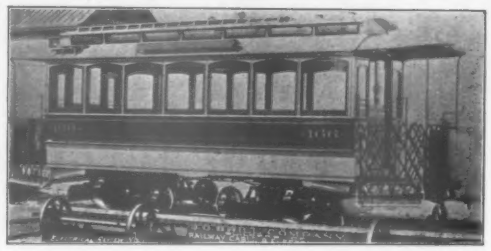

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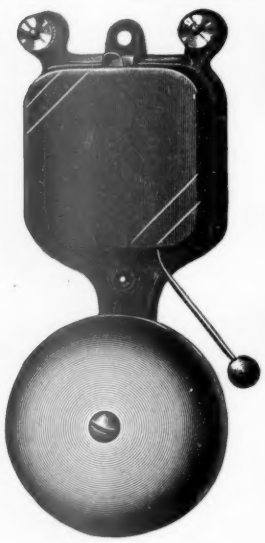

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